United States Department of Agriculture

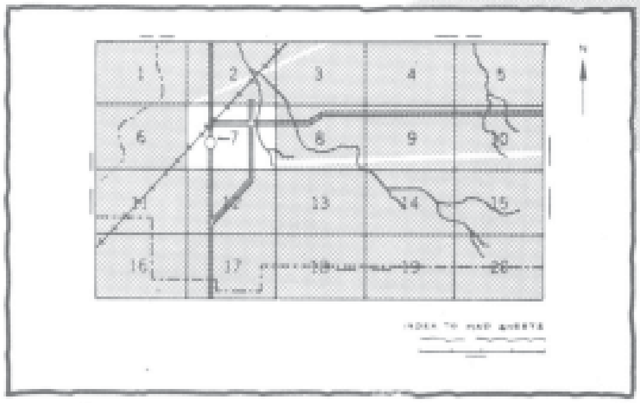
Soil Conservation Service

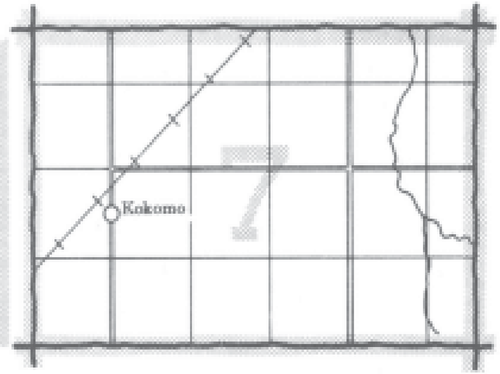
In Cooperation with the Minnesota Agricultural Experiment Station

Soil Survey of Clay County Minnesota

HOW TO USE

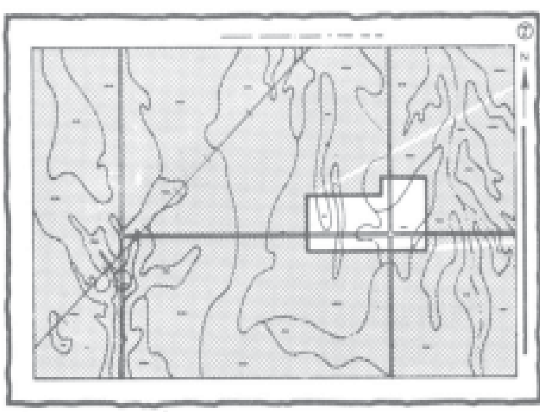
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

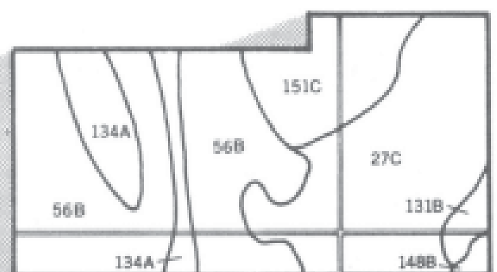




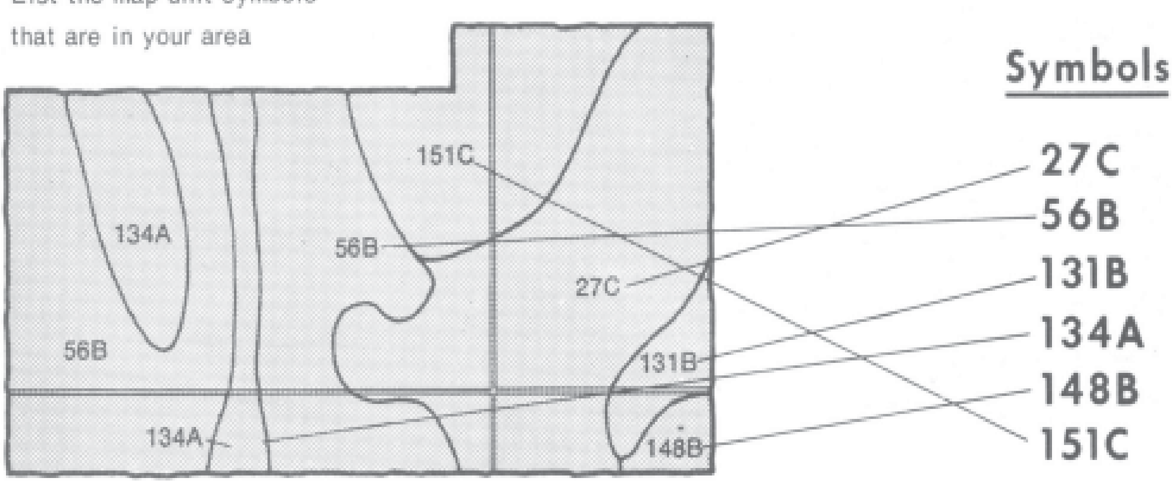
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



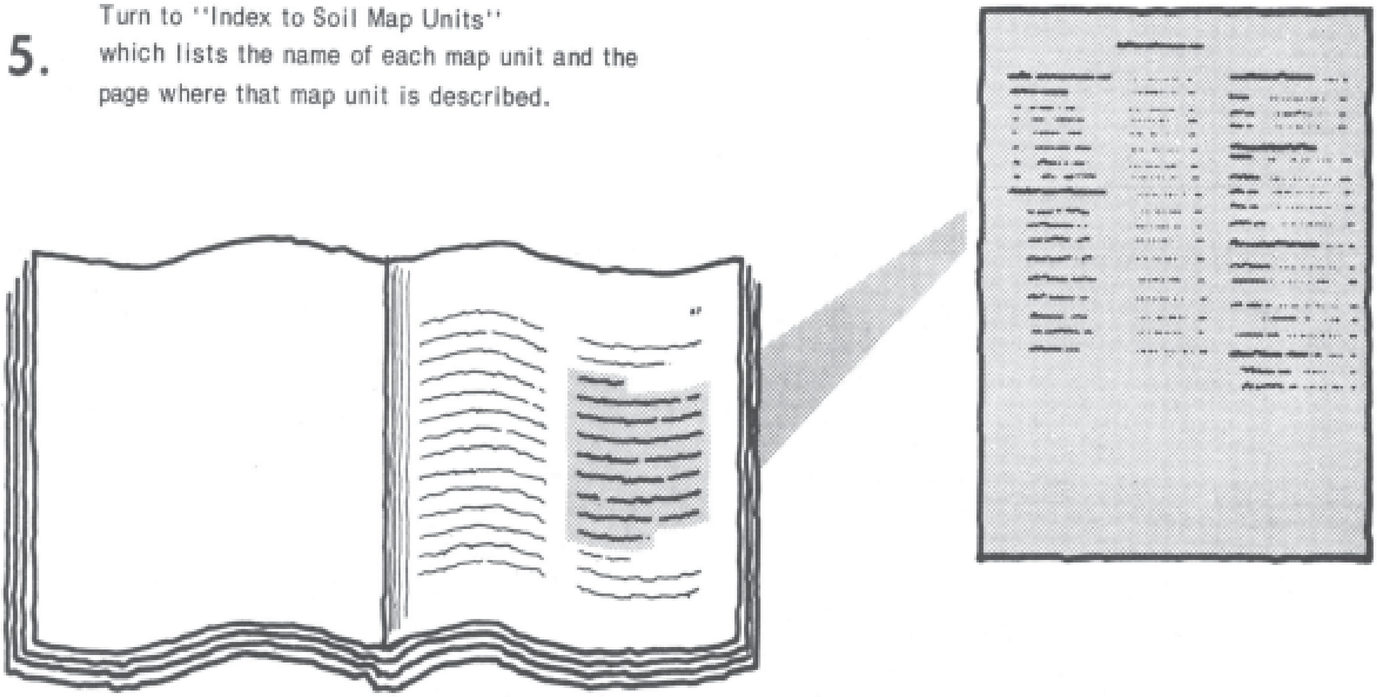


4. List the map unit symbols that are in your area

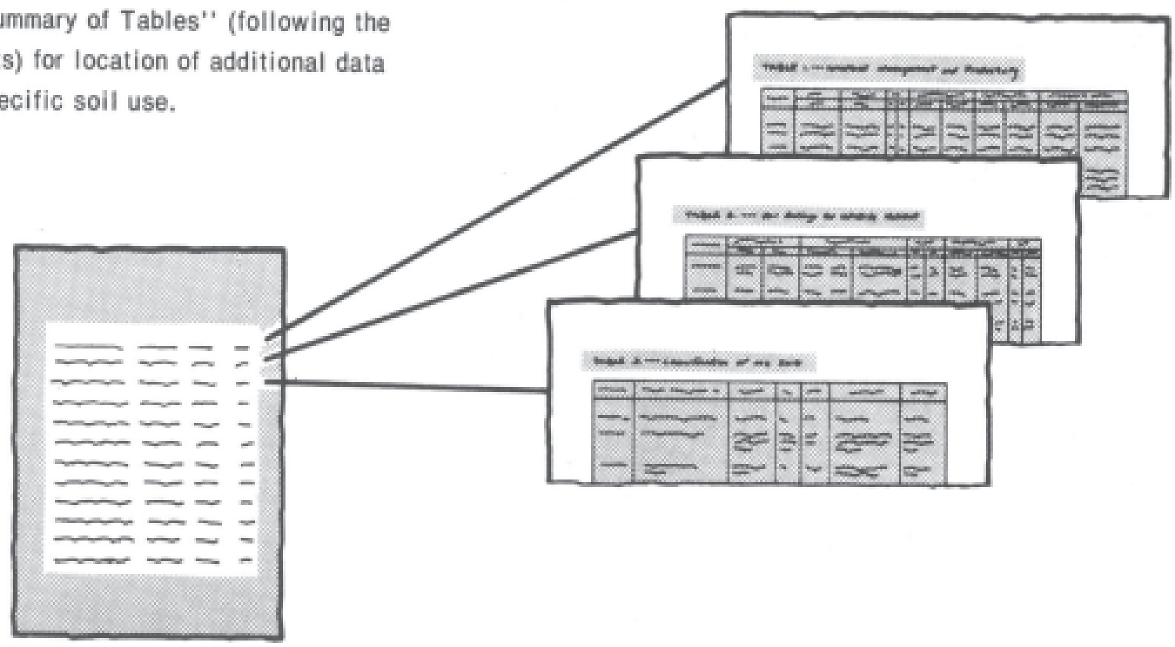


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture, Soil Conservation Service, and the Minnesota Agricultural Experiment station in cooperation with the Clay County Agricultural Extension Service, the Clay County Soil and Water Conservation Board, the Clay County Soil and Water Conservation District, and the Clay County Agricultural Stabilization and Conservation Service. The survey was partially funded by the Legislative Commission for Minnesota Resources and by Clay County.

Major fieldwork was performed in the period 1975 to 1979. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979. The first soil survey of Clay County was published in 1939 (*2*). This survey updates the first survey and provides additional information and larger maps that show soils in greater detail.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Fall plowing small grain on the Fargo association. The field on the right is sunflowers.

Contents

Soil series

Issued November 1982

Index to map units

Summary of tables

This page intentionally left blank.

Foreword

This soil survey contains information that can be used in land-planning programs in Clay County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some have steep slopes that limit their use. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Harry M. Major
State Conservationist
Soil Conservation Service

Location of Clay County in Minnesota.

Soil Survey of
Clay County, Minnesota

By Malvern N. Jacobson, Soil Conservation Service

Fieldwork by Charles E. Carr, Jon F. Hall, Malvern N. Jacobson
David A. Reedstrom, and Wayne L. Johannson, Soil Conservation Service
and Charles N. Gordon, Minnesota Agricultural Experiment Station

United States Department of Agriculture
Soil Conservation Service, and the
Minnesota Agricultural Experiment Station

General nature of the county

Clay County is in west-central Minnesota and borders the State of North Dakota. Moorhead is the county seat. The total area is about 1,052 square miles, or 673,280 acres. The total water area is about 5 square miles. Farming is the most important enterprise. Wheat, barley, oats, sugar beets, sunflowers, soybeans, some hay and pasture crops, and corn for feeding livestock produce most of the income in the county. Most industries in the county are related to agriculture; plants that process sugar beets and barley for malt are examples. Some recreational, farm, and light industrial products are also produced.

The soils of Clay County are dark colored and are nearly level to very steep. Soils in the western two-thirds of the county formed in lacustrine material. This material ranged from clay in the western part to sand and gravel in the eastern part. Soils in the eastern third of the county formed in mostly loamy till and sandy or gravelly outwash material.

The original vegetation in Clay County was largely tall prairie grasses and wetland reeds and sedges. Trees grew in the eastern part of the county.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Clay County is usually quite warm in the summer, with frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently surges over the county. Most precipitation falls during the warm period and is normally heaviest in late spring and early summer. Winter snowfall is normally not heavy, and it is blown into drifts so that much of the ground is nearly free of snow.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Hawley, Minnesota, for the period 1963 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 9° F, and the average daily minimum temperature is -1°. The lowest temperature on record, which occurred at Hawley on January 15, 1972, is -35°. In summer, the average temperature is 68°, and the average daily maximum temperature is 81°. The highest recorded temperature, which occurred on July 30, 1975, is 102°.

Growing degree days, shown in Table 1, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40°F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 22 inches. Of this, 75 percent usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 5.03 inches at Hawley on August 11, 1963. Thunderstorms occur on about 35 days each year, mostly in summer.

Average seasonal snowfall is 34 inches. The greatest snow depth at any one time during the period of record was 29 inches. At least 1 inch of snow is on the ground on an average of 85 days of the year, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 65 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The percentage of possible sunshine is 70 in summer and 50 in winter. The prevailing wind is from the north. Average windspeed is highest, 15 miles per hour, in April.

Most winters, several storms which have snow and high wind bring blizzard conditions to the county. During summer thunderstorms hail falls in small, scattered areas.

History and development

Clay County was named after Henry Clay of Lexington, Kentucky. It was established on March 8, 1862 and organized on April 14, 1872 (*7*). In 1970, the population was 46,608. Eleven incorporated cities are in the county: Barnesville, Comstock, Dilworth, Felton, Georgetown, Glyndon, Hawley, Hitterdal, Moorhead, Sabin, and Ulen. The present county seat, Moorhead, was first settled in 1871 and incorporated as a city on February 24, 1881. It is the largest city in the county. In 1977, it had a population of 31,789.

The first railroad in Clay County was built in 1871. Freight service is available in all parts of the county, and a cross-country passenger train has a stop in Fargo, North Dakota. Commercial air service is also available at Fargo. An all-weather airport for small craft in Hawley has a paved runway and landing lights. Bus service is available in Moorhead and in other nearby communities. The major highways and many of the county roads are paved or blacktopped. Interstate Highway 94 crosses the southern half of the county, U.S. Highway 10 crosses the county from east to west, and U.S. Highway 75 crosses the western part of the county from north to south. Minnesota Highways 9 and 32 cross the county from north to south, and Minnesota Highway 34 crosses the southeast portion of the county.

County and township roads serve the rural areas.

Grain elevators are throughout the county, and grain crops are marketed mainly in Duluth and Minneapolis-St. Paul. Some barley is marketed and processed in a malt plant located in Moorhead. Sugar beets are stockpiled in the county and are processed at plants in Crookston, Hillsboro, Moorhead and Wahpeton. Livestock is generally marketed in West Fargo and occasionally in South St. Paul. Creameries and plants for processing dairy products are also in the county.

Farming

Wheat, oats, barley, potatoes, and hay cut from the native prairie grasses were the principal crops produced by the first farmers in Clay County. These farmers found the prairie soil difficult to break but very productive once broken.

Wheat is now the most important cash crop in the county. In 1977, 217,300 acres was planted to wheat and 10,525,800 bushels were produced (*6*). The acreage in wheat varies annually in response to market prices. The acreage in sunflowers has generally been increasing. In 1974, about 195,925 acres was planted to wheat, 43,000 acres was in sugar beets, 25,000 acres was in sunflowers, 18,811 acres was in corn, 11,700 acres was in potatoes, 31,986 acres was in soybeans, and 95,500 acres was in other small grains. In 1977, about 217,300 acres was in wheat, 46,800 acres was in sugar beets, 52,000 acres was in sunflowers, 25,000 acres was in corn, 7,800 acres was in potatoes, 26,500 acres was in soybeans, and 124,500 acres was in other small grains.

Generally, the number of livestock in Clay County has decreased. The number of farmers raising livestock as part of their operation has fallen, although the number of livestock per farmer is commonly greater. Although a few feed lots and dairy farms operate in the western half of the county, livestock farms are more common in the eastern half of the county. Hay for livestock feed is also an important crop; in 1977, 24,000 acres was planted to hay and 61,900 tons were produced.

In 1977, 1,390 farms were in the county and the average farm size was 475 acres.

Woodland

Approximately 16,050 acres in Clay County is in native woodland. Woodlots in the eastern quarter of the county make up most of this acreage. Other areas are mainly along rivers, streams, and old stream channels. Bur oak, eastern cottonwood, northern red oak, green ash, boxelder, willow, and sugar maple are common on the eastern upland areas where Waukon, Barnes, Langhei, Hamerly, Vallers, and Gonvick soils are present. Eastern cottonwood, boxelder, quaking aspen, and some oak and elm species are common on sandy outwash and beach ridge areas of Sioux, Lohnes, Flaming, and

Poppleton soils. American elm, bur oak, common hackberry, boxelder, green ash, eastern cottonwood, American plum, and American basswood are common on areas of Wahpeton and Overly soils and the Fluvaquents, Haploborolls, Aquolls, and Udifluvents that are along rivers and streams in the western half of the county.

The early settlers used the trees for building materials, fence posts, and fuel. Today, the trees and shrubs are valued for wildlife habitat, esthetic value, recreation, watershed protection, and livestock protection.

Physiography, relief, and drainage

The highest elevations in Clay County are on the glacial morainic hills in the southeastern section near Rollag, about 1,515 feet above sea level. The lowest point, about 880 feet above sea level, is in the northwestern corner, where the Red River leaves the county.

The western two-thirds of the county is part of the glacial Lake Agassiz basin. The average distance from the Red River to the lowest of the major beaches deposited by Lake Agassiz is about 15 miles. The elevation of the Red River is about 110 feet lower than the top of this beach and is about 200 feet lower than the highest of the glacial lake beaches. From the highest beach, elevation decreases sharply toward the west, dropping as much as 50 feet in a half-mile or mile. Nearer the river, changes in elevation are smaller. In some areas of the basin, elevation shows little or no change over a mile or more.

The eastern third of the county is a complex upland area consisting of short, uneven slopes and many depressions and natural draws. Slopes in this area commonly range from nearly level to very steep.

The soils in the eastern third of the county formed in glacial till and, in places, in colluvium, alluvium, or outwash. The soils in the Lake Agassiz basin formed mainly in lacustrine sediments. These sediments are deep-water clays in the western part of the basin and become progressively coarser to the east, grading to silt and very fine sand, with sand and gravel on and near the shorelines.

All of the major drainage systems of the county empty into the Red River. Its primary tributaries are the South Branch of the Wild Rice River and the Buffalo River. The South Branch of the Wild Rice River drains the northeastern corner of the county and empties into the Wild Rice River in Norman County. The main branch of the Buffalo River drains the central and the northwestern parts of the county. The South Branch of the Buffalo River drains mostly the south-central portion of the county. Both the Wild Rice River and the Buffalo River flow west and north to the Red River. Numerous natural draws, coolies, and creeks also drain the county. An extensive system of ditches has been constructed to aid in draining excess water from farmlands.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock or coarse fragments. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures (*3*). They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

This page intentionally left blank.

General soil map units

The general soil map at the back of this publication shows broad areas, called soil associations, that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts and different soil patterns and map unit design, some soil boundaries and names in this soil survey do not match those in the soil survey of Norman County, Minnesota.

Soil descriptions

1. Fargo association

Nearly level to gently sloping, poorly drained soils which formed in silty to clayey lacustrine sediment; on lake plains

Local relief is slight, with some draws, depressions, and low ridges. Fargo soils typically are on broad flats or in shallow swales. In a few places they are on gentle slopes that typically are parallel to streams.

This association makes up about 16 percent of the survey area. It is about 78 percent Fargo soils and 22 percent soils of minor extent.

Typically, Fargo soils have a surface layer of black silty clay about 12 inches thick. The subsoil is very dark gray silty clay about 12 inches thick. The next layer is strongly calcareous, olive gray silty clay about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, olive gray silty clay.

Soils of minor extent in this association are the poorly drained Hegne soils mapped in complex with Fargo soils, the poorly drained Northcote soils, the somewhat poorly drained Cashel soils, and the somewhat poorly to moderately well drained Wahpeton soils. Cashel soils generally are in the lower areas and are subject to flooding. Hegne, Cashel, and Wahpeton soils are typically on slightly elevated positions. Northcote soils are on landscape positions similar to those of Fargo soils.

Nearly all of the acreage of this association is cultivated, and these soils are well suited to most crops grown in the county. Wheat, barley, sugar beets, sunflowers, and soybeans are the most common crops. A small acreage is in grassland or woodland. Most of the woodland is adjacent to the Red River. Wetness is the major limitation to the use of these soils as cropland. Controlling soil blowing and maintaining soil fertility are additional management concerns.

These soils are poorly suited to use as sites for buildings and most types of sanitary facilities because of wetness and because of the possibility of rare flooding under unusual weather conditions.

2. Bearden-Colvin association

Nearly level to gently sloping, somewhat poorly drained and poorly drained soils which formed in silty to clayey lacustrine sediment; on lake plains

Local relief is slight, with some draws, depressions, and low ridges. Bearden soils are on low ridges and swells and, in places, on gentle slopes that typically are parallel to streams. Colvin soils are on low flats and in shallow swales and depressions. Slopes range from 0 to 6 percent.

This association makes up about 17 percent of the survey area. It is about 55 percent Bearden soils, 23 percent Colvin soils, and 22 percent soils of minor extent.

Bearden soils are somewhat poorly drained. Typically, they have a surface layer of black silty clay loam about 12 inches thick. The next layer is very strongly calcareous, grayish brown silty clay loam about 12 inches thick. This grades to a strongly calcareous, mottled, grayish brown silt loam layer about 7 inches thick. The underlying material to a depth of 60 inches is mottled, grayish brown silty clay loam grading to mottled, grayish brown and light gray silt loam.

Colvin soils are poorly drained. Typically, they have a surface layer of black silty clay loam about 11 inches thick. The next layer is strongly calcareous, gray silt loam and silty clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silty clay and silty clay loam.

Soils of minor extent in this association are the poorly drained Augsburg and Fargo soils, the poorly drained Hegne soils mapped in complex with Fargo soils, and the moderately well drained Overly and Wheatville soils. Augsburg and Fargo soils are in gentle swales and depressions. Hegne, Overly, and Wheatville soils are on slightly elevated positions.

Nearly all of the acreage of this association is cultivated, and these soils are well suited to most crops grown in the county. Wheat, barley, sugar beets, sunflowers, soybeans, and potatoes are the most common crops. A small acreage, principally along the Buffalo River, is in woodland. The principal limitations to the use of these soils as cropland are wetness and the hazard of soil blowing. Other management concerns are compensating for the calcareous soil conditions in many areas and maintaining soil fertility.

These soils are poorly suited to use as sites for buildings and most types of sanitary facilities because of wetness.

3. Viking-Donaldson-Glyndon association

Nearly level to gently sloping, poorly drained to moderately well drained soils which formed in sandy to clayey lacustrine sediment, water modified till, and shoreline deposits; on lake plains

Local relief is ridgelike, with some swales, pockets, and natural draws. Viking soils are in swales and depressions. Donaldson and Glyndon soils are on slightly higher positions on the lake plain. Slopes range from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 24 percent Viking soils, 18 percent Donaldson soils, 15 percent Glyndon soils, and 43 percent soils of minor extent.

Viking soils are poorly drained. Typically, they have a surface layer of black sandy clay loam about 12 inches thick. The subsoil is dark grayish brown clay about 9 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown, dark grayish brown, and olive gray, strongly calcareous clay.

Donaldson soils are somewhat poorly drained and moderately well drained. Typically, they have a surface layer of black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 11 inches thick. This layer grades from very dark grayish brown to dark brown. The underlying material is mottled, brown fine sandy loam in the upper 6 inches and slightly calcareous, mottled, light brownish gray very fine sandy loam in the next 6 inches. Below that, to a depth of about 60 inches, it is strongly calcareous, dark gray clay.

Glyndon soils are somewhat poorly drained and moderately well drained. Typically, they have a surface layer of black loam about 10 inches thick. The next layer is very dark grayish brown loam 3 inches thick. Below this is a layer of very strongly calcareous, grayish brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, light yellowish brown very fine sandy loam and, below that, loamy very fine sand grading to mottled, light brownish gray very fine sand.

Soils of minor extent in this association are the poorly drained Fargo soils, the somewhat poorly drained Wyndmere soils, the somewhat poorly drained or moderately well drained Bearden and Elmville soils, and the moderately well drained Overly and Wheatville soils. Bearden, Overly, Wheatville, and Wyndmere soils are on slightly elevated knolls, low ridges, and swells. Elmville soils are on linear, slightly convex slopes. Fargo soils are in gentle swales and depressions.

Nearly all of the acreage of this association is cultivated. The soils are well suited to most crops grown in the county. Wheat, barley, sugar beets, soybeans, and sunflowers are the most common crops. A small acreage is in grassland and woodland. Some sand and gravel pits are also in this map unit. Sand and gravel below the level of the ground water aquifer have been removed from many of these pits, and the pits have filled with water (fig. 1). The principal hazard to use of these soils as cropland is soil blowing. Maintaining soil fertility and overcoming wetness are additional management concerns.

Most soils in this association are poorly suited to use as sites for buildings and most types of sanitary facilities because of wetness and the shrink-swell potential of the soils.

4. Glyndon-Wyndmere-Wheatville association

Nearly level to gently sloping, somewhat poorly drained and moderately well drained soils which formed in sandy to clayey lacustrine sediment; on lake plains

Local relief is slight, with some shallow draws and deeper depressions. Some areas of Glyndon and Wheatville soils are on gentle slopes that typically are parallel to streams. Most areas of Glyndon, Wheatville, and Wyndmere soils are on slightly elevated knolls, low ridges, and swells. Slopes range from 0 to 6 percent.

This association makes up about 18 percent of the county. It is about 22 percent Glyndon soils, 20 percent Wyndmere soils, 18 percent Wheatville soils, and 40 percent soils of minor extent.

Glyndon soils are somewhat poorly drained and moderately well drained. Typically, they have a surface layer of black loam about 10 inches thick. The next layer is very dark grayish brown loam 3 inches thick. This is underlain by a layer of strongly calcareous, grayish brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, light yellowish brown very fine sandy loam and loamy very

Figure 1.— Sand and gravel pit in the Viking-Donaldson-Glyndon association.

fine sand grading to mottled, light brownish gray very fine sand.

Wyndmere soils are somewhat poorly drained. Typically, they have a surface layer of black fine sandy loam about 10 inches thick. A layer of dark grayish brown fine sandy loam underlies the surface layer. Carbonates are concentrated in this layer, which is about 5 inches thick. Below this is a layer of very strongly calcareous, dark grayish brown and grayish brown loamy fine sand and fine sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is mottled, pale yellow fine sand grading to light brownish gray fine sand and very fine sand.

Wheatville soils are somewhat poorly drained and moderately well drained. Typically, they have a surface layer of very dark gray silt loam about 8 inches thick. The next layer is very strongly calcareous, light brownish gray silt loam about 6 inches thick. This is underlain by faintly mottled, pale brown very fine sandy loam about 10 inches thick. Below that to a depth of about 60 inches is mottled, olive gray and gray silty clay layered with silty clay loam and silt loam.

Soils of minor extent in this association are the poorly drained Augsburg and Borup soils and the somewhat poorly drained and moderately well drained Bearden and Elmville soils. The Augsburg and Borup soils are in swales and depressions and on broad low flats. The Bearden and Elmville soils are on slightly higher parts of the landscape.

Nearly all of the acreage of this association is cultivated, and these soils are well suited to most crops grown in the county. Wheat, barley, sugar beets, sunflowers, potatoes, and soybeans are the most common crops. A small acreage, principally along rivers and streams, is in woodland. The susceptibility of these soils to soil blowing is the principal hazard to their use as cropland. Maintaining soil fertility and controlling wetness in the poorly drained areas are additional management concerns.

These soils are poorly suited to use as sites for buildings and most types of sanitary facilities because of wetness.

5. Ulen-Arveson-Flaming association

Nearly level, very poorly drained to moderately well drained soils which formed in loamy to sandy lacustrine sediment; on outwash plains and in lake basins

Local relief is slight, with some shallow draws, deeper depressions, and pronounced ridges. Arveson soils are in shallow draws and slight depressions. Ulen and Flaming soils are on slightly higher positions and on broad flats. Slopes range from 0 to 3 percent.

This association makes up about 10 percent of the survey area. It is about 22 percent Ulen soils, about 20 percent Arveson soils, about 18 percent Flaming soils, and about 40 percent soils of minor extent.

The Ulen soils are somewhat poorly drained and moderately well drained. Typically, they have a surface layer of black fine sandy loam about 8 inches thick. Below it is a layer of strongly calcareous, very dark gray fine sandy loam about 5 inches thick. In the next 12 inches is very strongly calcareous, dark grayish brown sandy loam grading to grayish brown loamy fine sand. The underlying material to a depth of about 60 inches is light olive brown loamy fine sand grading to mottled, olive yellow and light brownish gray fine sand.

Arveson soils are poorly drained and very poorly drained. Typically, they have a surface layer of strongly calcareous, very dark gray clay loam about 8 inches thick. The next layer is strongly calcareous, very dark gray loam and silt loam about 6 inches thick. Below this is a layer of very strongly calcareous, mottled, light gray loam about 20 inches thick. The underlying material to a depth of about 60 inches is mottled, gray sandy loam.

Flaming soils are moderately well drained and somewhat poorly drained. Typically, the Flaming soils have a surface layer of very dark brown fine sand about 13 inches thick. The subsoil, which is about 22 inches thick, is very dark grayish brown fine sand grading to mottled, dark brown and brown fine sand. The underlying material to a depth of about 60 inches is mottled, light brownish gray fine sand.

Soils of minor extent in this association are the moderately well drained Swenoda soils, the moderately well drained and somewhat poorly drained Grimstad soils, the poorly drained Rockwell and Vallers soils, and the very poorly drained Haplaquolls and Histosols. Swenoda and Grimstad soils typically are on knolls and swells. Rockwell and Vallers soils typically are in depressions or on broad low flats. Haplaquolls and Histosols are in the deeper, more pronounced depressions.

Many areas of this association are cultivated, and these soils are moderately suited to most crops grown in the survey area. Small grain, corn, sunflowers, and hay or pasture are the main crops. Some acreage, especially in depressions and in areas of organic soils, is difficult to drain and is idle. A small acreage, principally along stream channels, is in woodland. The susceptibility of these soils to soil blowing is the principal hazard to their use as cropland. Maintaining soil fertility and controlling wetness in the poorly drained areas are additional management concerns.

This association is poorly suited to use as sites for buildings and most types of sanitary facilities because of wetness and the hazard of flooding.

6. Lohnes-Sioux association

Nearly level to very steep, moderately well drained to excessively drained soils which formed in loamy to sandy outwash material; on lake beaches and outwash plains

Local relief varies, having hills, ridges, and broad flats. Lohnes soils are on the nearly level to gently sloping areas. Sioux soils are on the more sloping areas, side slopes, and crests of hills and ridges. Slopes range from 0 to 30 percent.

This association makes up about 12 percent of the survey area. It is about 25 percent Lohnes soils, about 20 percent Sioux soils, and about 55 percent soils of minor extent.

Lohnes soils are moderately well drained and well drained. Typically, they have a surface layer of black loamy sand about 10 inches thick. The underlying material to a depth of about 60 inches is brown and grayish brown coarse sand.

Sioux soils are excessively drained. Typically, they have a surface layer of black sandy loam about 9 inches thick. This grades to dark brown gravelly loamy coarse sand about 5 inches thick. The underlying material to a depth of 60 inches is brown gravelly loamy coarse sand grading to light yellowish brown gravelly loamy coarse sand.

Soils of minor extent in this association are the poorly drained Arveson, Rockwell, and Vallers soils and the somewhat poorly drained to moderately well drained Flaming and Ulen soils. Arveson, Rockwell, and Vallers soils are in swales and depressions and on broad low flats. Flaming and Ulen soils typically are on nearly level and slightly convex areas.

These soils are poorly suited to crop production, and less than half of the acreage of this association is cultivated. Small grain, sunflowers, corn, and some legumes are the main crops. The rest of the acreage is in permanent hay or pasture, in woodland, or idle. Sioux soils are a good source of sand and gravel (fig. 2). Droughtiness is the principal limitation to cropland use. Controlling soil blowing and maintaining soil fertility are additional management concerns.

In the less sloping areas these soils are well suited to use as building sites. These soils are poorly suited to use as sites for most types of sanitary facilities. The poor filtering capacity of most of these soils, which can result in pollution of ground water by the effluent, is the principal limitation to this use.

Figure 2.— Sand and gravel pit in an area of Sioux sandy loam, 1 to 6 percent slopes.

7. Barnes-Langhei association

Nearly level to hilly, well drained soils which formed in loamy glacial till; on uplands

Local relief typically varies, having short, complex slopes, deep depressions, well defined drains, and low valleys. Barnes soils are on the slightly lower, less sloping areas. Langhei soils are on knobs and breaks of steeper slopes (fig. 3). Slopes range from 1 to 18 percent.

This association makes up about 22 percent of the survey area. It is about 40 percent Barnes soils, about 25 percent Langhei soils, and about 35 percent soils of minor extent.

Typically, Barnes soils have a surface layer of black loam about 9 inches thick. The subsoil is brown and yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, pale brown, and light olive brown, calcareous loam.

Typically, Langhei soils have a surface layer of strongly calcareous, grayish brown loam about 8 inches thick. The next layer, which is about 9 inches thick, is very strongly calcareous, yellowish brown and brown loam. The underlying material to a depth of about 60 inches is yellowish brown, strongly calcareous loam.

Soils of minor extent in this association are the somewhat poorly drained and moderately well drained Hamerly soils and the poorly drained Flom and Vallers soils. Hamerly soils are on nearly level to gently undulating areas, and Flom and Vallers soils are in swales and deep depressions.

Most of the acreage of this association is cultivated, and these soils are moderately suited to most crops grown in the county. Small grain, hayland and pasture crops, corn, sunflowers, and some legumes are the most common crops. A small acreage, primarily along the Wild Rice River, is in woodland. Erosion by wind and water is the principal hazard to use of these soils as cropland.

Figure 3.— Typical landscape in the Barnes-Langhei association. Barnes soils are on the dark colored areas. Langhei soils are on the light colored knobs.

Maintaining soil fertility is an additional management concern. Wetness is a limitation in the low-lying areas.

The soils in this association are moderately suited to use as sites for buildings and most types of sanitary facilities. Slope is the principal limitation to the use of these soils as building sites. Septic tank absorption fields may not function properly in these moderately permeable soils, and onsite investigation is needed to determine the suitability of individual areas for this use.

8. Waukon-Langhei association

Nearly level to very steep, well drained soils which formed in loamy glacial till; on uplands

Local relief is variable, having short complex slopes with many small lakes and numerous depressions. Waukon soils are on the slightly lower, less sloping areas. Langhei soils are on knobs and breaks of steeper slopes. Slopes range from 1 to 30 percent.

This association makes up about 3 percent of the survey area. It is about 35 percent Waukon soils, about 25 percent Langhei soils, and about 40 percent soils of minor extent.

Typically, Waukon soils have a surface layer of very dark brown fine sandy loam about 10 inches thick. The subsoil is 24 inches thick. It is dark yellowish brown sandy clay loam in the upper 10 inches and grades to yellowish brown fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, calcareous fine sandy loam.

Typically, Langhei soils have a surface layer of strongly calcareous, grayish brown loam about 8 inches thick. The next layer, about 9 inches thick, is very strongly calcareous, yellowish brown and brown loam. The underlying material to a depth of about 60 inches is yellowish brown, strongly calcareous loam.

Soils of minor extent in this association are the moderately well drained Darnen soils and the poorly drained Flom and Vallers soils. Darnen soils are on nearly level landscapes, and Flom and Vallers soils are in swales and deep depressions.

The less sloping soils are well suited to most crops commonly grown in the county, and most of the acreage of these soils is cultivated. Small grain, hay, corn, and some legumes are the most common crops. The steeper soils are used for pasture. Some of these soils are in woodland. Erosion by wind or water is the principal hazard to use of these soils as cropland. Droughtiness is an additional management concern.

Most of the less sloping soils are well suited to use as building sites and moderately suited to use as sites for most types of sanitary facilities. Septic tank absorption fields may not function properly in these soils, which have moderate permeability.

This page intentionally left blank.

Detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Fargo silty clay, 0 to 2 percent slopes, is one of several phases in the Fargo series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Barnes-Langhei loams, 1 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Haplaquolls and Histosols, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil descriptions

33B—Barnes loam, 1 to 3 percent slopes. This well drained, nearly level and gently undulating soil is on uplands. Individual areas are irregular in shape and typically range from 4 to 100 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is brown and yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, pale brown, and light olive brown, calcareous loam. In places, sand and gravel layers are in the underlying material. In some areas, more very fine sand or silt is in the profile. In some areas, moderate erosion has removed part of the topsoil.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Darnen, Kittson, and Langhei soils. Darnen soils are moderately well drained and have a thick, dark surface layer. Kittson soils are somewhat poorly drained or moderately well drained and are on slightly lower areas than the Barnes soils. Langhei soils are on the crests of knobs and the breaks of slopes. They have a thin, grayer, strongly calcareous surface layer. Also included in mapping are some small areas of poorly drained soils in depressions.

Permeability of this soil is moderate. Both the available water capacity and the organic matter content are high. Surface runoff is medium. Reaction in the surface layer is neutral.

Most areas of this soil are cultivated. This soil is well suited to crop production. Small grain, sunflowers, corn, soybeans, and hay are the most common crops. The principal management concern is maintaining soil tilth and fertility.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is commonly low to moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicide help to remove competing plants and establish a good stand of trees.

This soil is well suited to use as building sites. Roads can be constructed on well compacted, coarse textured fill material to protect them from damage caused by the low strength of the soil and frost action in the soil.

This soil does not readily absorb effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

This soil is in capability subclass IIc.

33B2—Barnes loam, 2 to 6 percent slopes, eroded. This well drained, gently undulating soil is on uplands. Individual areas are irregular in shape and typically range from 10 to 200 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is brown loam about 6 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, pale brown, and light olive brown, calcareous loam. In places, sand and gravel layers are in the underlying material. Some areas have a higher percentage of very fine sand or silt. Some areas have little or no erosion. In places, slopes are greater than 6 percent.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Darnen, Kittson, and Langhei soils. Darnen soils typically are on positions at the base of slopes, are moderately well drained, and have a thick, dark colored surface layer. Kittson loam soils are somewhat poorly drained and moderately well drained and are on lower portions of the landscape than the Barnes soils. Langhei soils are on the crests of knobs or breaks of slopes.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is medium to rapid. Reaction in the surface layer is neutral.

Most areas of this soil are cultivated. This soil is well suited to crop production. Small grain, sunflowers, corn, soybeans, and hay are the most common crops. Some areas are in pasture.

Erosion by wind and water is the principal hazard to cropping this soil. This hazard is severe because the soil is already eroded. Erosion can be reduced by returning crop residue to the soil, rough tillage, and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways prevent the formation of rills and gullies.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain organic matter content and tilth and fertility.

This soil is suited to most windbreak trees and to shrubs that have no climatic or disease limitation. Seedling mortality is commonly low to moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants and establish a good stand of trees.

This soil is well suited to use as building sites. Roads can be constructed on well compacted, coarse textured fill material to protect them from damage caused by the low strength of the soil and frost action in the soil.

This soil does not readily absorb effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

This soil is in capability subclass IIe.

33C2—Barnes loam, 6 to 12 percent slopes, eroded. This well drained, rolling soil is on uplands. Individual areas are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is very dark grayish brown or dark brown loam about 9 inches thick. The subsoil is brown loam about 6 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, pale brown, and light olive brown, calcareous loam. In places, sand and gravel layers are in the underlying material. Some areas have a higher percentage of very fine sand or silt in the profile. Some areas show little or no evidence of erosion. In some places, slopes are slightly greater than 12 percent.

Included with this soil in mapping, and making up 5 to 12 percent of most mapped areas, are small areas of Darnen, Langhei, and Sverdrup soils. Darnen soils are moderately well drained and have a thick, dark colored surface layer. Langhei soils typically are on the crests of knobs and breaks of slopes. They have a thin, strongly calcareous surface layer that is grayer than the surface layer of the Barnes soils. Sverdrup soils are somewhat excessively drained and are on sandy convex positions.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is rapid. Reaction in the surface layer is neutral.

Most areas of this soil are cultivated. This soil is moderately suited to crop production. Small grain, sunflowers, corn, soybeans, hay, and pasture are the most common crops. Water erosion is the principal hazard to cropping this soil. This hazard is severe because the soil is already eroded. Slope limits or modifies some field operations. Planting row crops up and down slopes may channel runoff and increase the amount of erosion. Erosion can be reduced by returning crop residue to the soil and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways prevent the formation of rills and gullies by running water.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is low to moderate, and plant competition is commonly severe. Weed control, cultivation, and applications of herbicides help remove competing plants and establish a good stand of trees.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads can be constructed on well compacted, coarse textured fill material to protect them from damage caused by the low strength of the soil and frost action in the soil. Roads should be constructed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

Because of slope and moderate permeability this soil does not readily absorb effluent from septic tanks. Installing a larger than average drain field and placing distribution lines across the slope help to overcome these limitations.

This soil is in capability subclass IIIe.

36—Flom clay loam. This poorly drained, nearly level soil is in swales and shallow depressions in the uplands. A small acreage is on low, level areas on the lake-washed till plain. Individual areas are irregular in shape and typically range from 3 to 30 acres.

Typically, the surface layer is black clay loam about 9 inches thick. The next layer is very dark gray clay loam about 5 inches thick. The subsoil is dark gray silty clay loam about 9 inches thick. The underlying material to a depth of about 60 inches is olive gray and light olive gray, mottled, calcareous loam. In some areas the surface layer is thicker and is black or very dark gray to a depth greater than 24 inches. In places, the clay content is slightly greater than 35 percent. Some areas have sandy and gravelly layers in the underlying material.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Kittson, Rockwell, and Vallers soils. Kittson soils are somewhat poorly drained and moderately well drained and are on slightly higher positions than the Flom soil. Rockwell soils are on similar positions on the lake-washed till plain. They are more calcareous at and near the surface. Vallers soils are on similar landscape positions. They differ mainly in being strongly calcareous at and near the surface.

Permeability of this soil is moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is mildly alkaline. The depth to the seasonal high water table is 1 foot to 3 feet.

Most areas of this soil are cultivated. This soil is well suited to crop production. Small grain is the most common crop. Row crops, such as sunflowers and corn, are also grown. Some areas are in permanent pasture and hay crops, and a few areas are idle.

Wetness is the principal limitation to cropping this soil. Most excess water can be removed by constructing open field ditches and by deepening and widening natural watercourses.

Maintaining soil tilth and fertility is an additional management concern. Returning crop residue to the soil and plowing under green manure crops help maintain the organic matter content and the fertility of the soil. Delaying cultivation while this soil is wet reduces damage to soil structure and allows for preparation of a more suitable seedbed.

This soil is best suited to windbreak trees and shrubs which tolerate wetness. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants and establish a good stand of trees.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without basements. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to protect them from damage caused by the low strength of the soil and frost action in the soil.

This soil is generally not suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

38B—Waukon fine sandy loam, 1 to 6 percent slopes. This well drained, nearly level and gently undulating soil is on uplands. Individual areas are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is very dark brown fine sandy loam about 10 inches thick. The subsoil is 24 inches thick. It is dark yellowish brown sandy clay loam in the upper 10 inches and grades to yellowish brown fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, calcareous fine sandy loam. In some places, sand and gravel layers are in the underlying material. Some areas, especially in southeastern Eglon and northwest Parke Townships, have more clay in the upper part. Some areas have beer moderately eroded. In places, slopes are slightly greater than 6 percent.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Gonvick and Sverdrup soils. Gonvick soils are moderately well drained, have a higher clay content, and typically are on slightly lower positions than the Waukon soil. Sverdrup soils are somewhat excessively drained, are on similar landscapes, and formed in sandy loam upper sediment over sandy underlying materials.

Permeability of this soil is moderate. Both the available water capacity and the organic matter content are high. Surface runoff is medium to rapid. Reaction in the surface layer is slightly acid.

Most areas of this soil are cultivated. This soil is well suited to crop production. Small grain, sunflowers, corn, soybeans, and hay are the most common crops. Some areas are in pasture.

Water erosion is the principal management concern in cropping this soil. Erosion can be reduced by returning crop residue to the soil and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways prevent the formation of rills and gullies.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is commonly low to moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants and establish a good stand of trees.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by frost action in the soil and by shrinking and swelling of the soil.

This soil does not readily absorb effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

This soil is in capability subclass IIe.

38B2—Waukon loam, 2 to 6 percent slopes, eroded. This well drained, gently undulating soil is on upland landscapes. Individual areas are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is dark brown loam about 8 inches thick. The subsoil is dark yellowish brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, calcareous fine sandy loam. In places, sand and gravel layers are in the underlying material. Some areas, especially in southeastern Eglon and northeastern Parke Townships, have more clay in the upper part. In some areas there is little or no evidence of erosion. In places, slopes are slightly greater than 6 percent.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Darnen, Gonvick, and Langhei soils. Darnen soils are moderately well drained and have a thicker surface layer than the Waukon soil. Gonvick soils are moderately well drained and typically are on slightly lower positions. Langhei soils are on knobs and breaks of slopes. They have a thin, grayish, strongly calcareous surface layer. A few small areas of more sandy, somewhat excessively drained Sverdrup soils are also included.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate. Surface runoff is medium to rapid. Reaction in the surface layer is neutral.

Most areas of this soil are cultivated. This soil is well suited to crop production. Small grain, sunflowers, corn, soybeans, and hay are the most common crops.

Water erosion is the principal hazard to cropping this soil. This hazard is severe because the soil is already eroded. Returning crop residue to the soil and, where feasible, planting on the contour can reduce erosion by wind and water. In areas of concentrated runoff, grassed waterways can prevent the formation of rills and gullies.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is commonly low to moderate, and plant competition is severe.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by frost action and by shrinking and swelling.

This soil does not readily absorb effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

This soil is in capability subclass IIe.

38C—Waukon fine sandy loam, 6 to 12 percent slopes. This well drained, rolling soil is on upland landscapes. Individual areas of this soil are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is very dark brown fine sandy loam about 10 inches thick. The subsoil is brown and yellowish brown sandy clay loam about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, calcareous loam and fine sandy loam. In places, sand and gravelly layers are in the underlying material. A few areas, especially in southeastern Eglon and northeastern Parke Townships, have 35 to more than 45 percent clay in the surface layer and subsoil. The topsoil has been moderately eroded in some areas. In places, slopes are slightly greater than 12 percent.

Included with this soil in mapping, and making up 5 to 12 percent of most mapped areas, are small areas of Gonvick and Sverdrup soils. Gonvick soils are moderately well drained and typically are on slightly lower positions than the Waukon soil. Sverdrup soils are somewhat excessively drained, are on similar landscapes, and formed in sandy loam upper sediment over sandy underlying materials.

Permeability of this soil is moderate. Both the available water capacity and the organic matter content are high. Surface runoff is rapid. Reaction in the surface layer is slightly acid.

Many areas of this soil are cultivated. This soil is moderately suited to crop production. Small grain, sunflowers, corn, soybeans, and hay are the most common crops.

Water erosion is the principal management concern in cropping this soil. Planting row crops up and down slopes may channel runoff and increase the amount of erosion. Erosion can be reduced by returning crop residue to the soil and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways prevent the formation of rills and gullies.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help to maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is low to moderate, and plant competition is commonly severe.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil. Roads should be constructed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard. Constructing roads on well compacted, coarse textured base material helps to protect them from damage caused by frost action in the soil and by shrinking and swelling of the soil with changes in moisture content.

The slope and moderate permeability of this soil prevent it from readily absorbing effluent from septic tanks. Installing a larger than average drain field and placing distribution lines across the slope help to overcome these limitations.

This soil is in capability subclass IIIe.

38C2—Waukon loam, 6 to 12 percent slopes, eroded. This well drained, rolling soil is on upland landscapes. Individual areas are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is dark brown loam about 8 inches thick. The subsoil is dark yellowish brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown calcareous loam and fine sandy loam. In places, sand and gravel layers are in the underlying material. Some areas, especially in southeastern Eglon and northeastern Parke Townships, have more clay in the surface layer and subsoil. In some areas there is little or no evidence of erosion. In places, slopes are slightly greater than 12 percent.

Included with this soil in mapping and making up 10 to 15 percent of most mapped areas are small areas of Darnen, Gonvick, and Langhei soils. Darnen soils are moderately well drained and have a thicker surface layer than the Waukon soil. Gonvick soils are moderately well drained and typically are on slightly lower positions. Langhei soils are on knobs and breaks of slopes. They have a thin, grayish, strongly calcareous surface layer. A few small areas of more sandy, somewhat excessively drained Sverdrup soils are also included.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate. Surface runoff is rapid. Reaction in the surface layer is neutral.

Most areas of this soil are cultivated. This soil is moderately suited to crop production. Small grain, sunflowers, corn, soybeans, and hay are the most common crops.

Water erosion is the principal hazard to cropping this soil. This hazard is severe because the soil is already eroded. Planting row crops up and down slopes may channel runoff and increase the amount of erosion. Erosion can be reduced by returning crop residue to the soil and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways prevent the formation of rills and gullies.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is low to moderate, and plant competition is commonly severe.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads constructed on this soil should be placed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard. Constructing roads on well compacted, coarse textured base material helps to protect them from damage caused by frost action and by shrinking and swelling.

The slope and moderate permeability of this soil prevent it from readily absorbing effluent from septic tanks. Installing a larger than average drain field and placing distribution lines across the slope help to overcome these limitations.

This soil is in capability subclass IIIe.

38D—Waukon fine sandy loam, 12 to 18 percent slopes. This well drained, hilly soil is on upland landscapes. Individual areas are irregular in shape and typically range from 3 to 40 acres.

Typically, the surface layer is very dark brown fine sandy loam about 10 inches thick. The subsoil is dark yellowish brown and yellowish brown sandy clay loam about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, calcareous loam and fine sandy loam. In places, sand and gravel layers are in the underlying material. A few areas, especially in southeastern Eglon and northeastern Parke Townships, have more clay in the surface layer and subsoil. A few areas show evidence of moderate erosion. In places, slopes are slightly greater than 18 percent.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Gonvick and Sverdrup soils. Gonvick soils are moderately well drained and typically are on slightly lower and less sloping positions than the Waukon soil. Sverdrup soils are somewhat excessively drained, are on similar landscapes, and formed in sandy loam upper sediment and sandy underlying material.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is rapid to very rapid. Reaction in the surface layer is slightly acid.

Most areas of this soil are cultivated or are pastured. Other areas are wooded. Oak is the most common species grown. This soil is poorly suited to crop production. Small grain and hay are the most common crops. Slope limits or modifies many field operations.

Water erosion is the principal hazard to cropping this soil. Planting row crops up and down slopes may channel runoff and increase the amount of erosion. Erosion can be reduced by returning crop residue to the soil and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways can be used to prevent the formation of rills and gullies.

Maintaining soil tilth and fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is low to moderate, and plant competition is commonly severe. Weed control, cultivation, and applications of herbicides help remove competing plants. Slope limits equipment operation.

Slope is the main limitation to use of this soil as building sites. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Extensive cutting and filling is generally needed if roads are constructed on this soil. Roads should be placed on the contour, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard. Land shaping and installing distribution lines across the slope are generally necessary to insure proper operation of septic tank absorption fields.

This soil is in capability subclass IVe.

38D2—Waukon loam, 12 to 18 percent slopes, eroded. This well drained, hilly soil is on upland landscapes. Individual areas are irregular in shape and typically range from 3 to 50 acres.

Typically, the surface layer is dark brown loam about 8 inches thick. The subsoil is dark yellowish brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, calcareous loam and fine sandy loam. In places, sand and gravel layers are in the underlying material. Some areas, especially in southeastern Eglon and northeastern Parke Townships, have more clay in the surface layer and subsoil. In places, slopes are slightly greater than 18 percent.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Darnen, Gonvick, and Langhei soils. Darnen soils are moderately well drained and have a surface layer that is thicker than the surface layer of the Waukon soil and formed in materials washed from adjacent slopes. Gonvick soils are moderately well drained and typically are on lower, less sloping positions. Langhei soils are somewhat excessively drained and are commonly on knobs and breaks of slopes. They have a thin, grayish, strongly calcareous surface layer. A few small areas of more sandy Sverdrup soils are also included in mapping.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate. Surface runoff is rapid to very rapid. Reaction in the surface layer is neutral.

Many areas of this soil are cultivated, but this soil is poorly suited to crop production. Small grain, hay, and pasture are the most common crops. A small acreage is in row crops, principally corn. Slope limits or modifies field operations. Planting row crops up and down slopes may channel runoff and increase the amount of soil eroded by water.

Water erosion is the principal hazard to cropping this soil. This hazard is severe because slopes are moderately steep and the soil is already eroded. Water erosion can be reduced by returning crop residue to the soil, and, where feasible, planting on the contour. In areas of concentrated runoff, grassed waterways reduce the formation of rills and gullies. Maintaining soil fertility is also a management concern. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help maintain the organic matter content, structure, and fertility of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is low to moderate, and plant competition is commonly severe. Weed control, cultivation, and applications of herbicides help to remove competing plants. Slope limits equipment operation.

Slope is the main limitation to the use of this soil as building sites. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Constructing roads on this soil generally requires extensive cutting and filling. Roads should be placed on the contour and roadbanks should be planted to well adapted grasses to minimize the erosion hazard. Land shaping and installing distribution lines across the slope are generally necessary for the proper operation of septic tank absorption fields.

This soil is in capability subclass IVe.

38E—Waukon fine sandy loam, 18 to 30 percent slopes. This well drained, steep and very steep soil is on upland landscapes, commonly adjacent to small lakes. Individual areas are irregular in shape and typically range from 3 to 30 acres.

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsoil is brown and yellowish brown sandy clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown, calcareous loam and fine sandy loam. In places, sandy and gravel layers are in the underlying material. A few areas have more clay in the solum. In places, slopes are greater than 30 percent.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Lohnes and Sioux soils. Lohnes soils are well drained and, in places, excessively drained. They formed in sand and gravel. Sioux soils are excessively drained and formed in gravel and sand. Bouldery areas of Sioux soils have many stones scattered on the surface and in the underlying material.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is very rapid. Reaction in the surface layer is slightly acid to neutral.

Most areas of this soil are in woodland, and oak is the most common tree. These areas are generally idle or included in areas used as pasture. This soil is best suited to upland wildlife habitat. This soil is too steep for the operation of most farm machines and is generally not suited to crop production. Very rapid runoff removes soil material in areas where the soil is not protected by vegetative cover.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is low to moderate, and plant competition is commonly severe. Weed control, cultivation, and applications of herbicides help to remove competing plants. Slope severely limits the operation of equipment.

Slope is the main limitation to the use of this soil as building sites. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Constructing roads on this soil generally requires extensive cutting and filling. Erosion can be minimized by placing roads on the contour and planting roadbanks to well adapted grasses.

Slope limits the installation of sanitary facilities on this soil. Land shaping and installing distribution lines across the slope are generally necessary for the proper operation of septic tank absorption fields.

This soil is in capability subclass VIe.

45B—Maddock fine sand, 0 to 4 percent slopes. This well drained, nearly level and gently sloping soil is on the crests and upper side slopes of ridges on lake plains and upland landscapes. Individual areas of this soil are irregular in shape and typically range from 10 to 100 acres.

Typically, the surface layer is black fine sand about 10 inches thick. The subsoil is very dark brown and dark grayish brown fine sand about 13 inches thick. The underlying material to a depth of about 60 inches is brown and dark brown sand and fine sand. In places, the surface layer is sandy loam or fine sandy loam less than 7 inches thick. A few mottles are in the underlying material of some pedons. In some places, layers of very fine sand and silt loam are below the surface layer and typically below the solum. Some cementation or firmness is common in these layers. In a few places, the soil contains strata of medium and coarse sand.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Flaming, Lohnes, and Sverdrup soils. Flaming soils are somewhat poorly drained and moderately well drained. Lohnes soils are moderately well drained and well drained. They differ from the Maddock soil mainly by having more gravel in the underlying material. Sverdrup soils are somewhat excessively drained. They differ mainly by having sandy loam in the surface layer and the subsoil.

Permeability of this soil is rapid. Both the available water capacity and the organic matter content are low.

Surface runoff is slow. Reaction in the surface layer is neutral.

Most areas are used for hayland or pasture. Some areas of this soil are cultivated. Small grain, sunflowers, and corn are the most common crops. A few areas are idle, and some of these are wooded. This soil is poorly suited to crop production.

A low available water capacity is the principal limitation to cropping this soil. Soil blowing is also a concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Practices such as returning crop residue to the soil and establishing field shelterbelts hold snow cover and reduce the drying effect of wind, thereby allowing the conservation and better use of available water. These practices also help to control soil blowing. If water is available, irrigation may be considered to assure adequate moisture for plant growth. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, applying fertilizer, and controlling weeds.

This soil is best suited to windbreak trees and shrubs which have some tolerance of drought. In some seasons, droughty conditions may cause moderate to severe seedling mortality.

This soil is well suited to use as sites for buildings and local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

This soil is in capability subclass IVs.

45C—Maddock fine sand, 4 to 12 percent slopes. This well drained, gently sloping and sloping soil is on upper side slopes of ridges and on convex, sloping areas parallel to swales and natural drainage channels. It is on lake plains and upland landscapes. Individual areas of this soil are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is black fine sand about 8 inches thick. The subsoil is very dark brown and dark grayish brown fine sand about 13 inches thick. The underlying material to a depth of about 60 inches is brown and dark brown sand and fine sand. In places, the surface layer is sandy loam or fine sandy loam less than 7 inches thick. In some pedons, layers of very fine sand and silt loam are below the surface layer and below the solum. Some cementation or firmness is common in these layers. In a few places the soil has strata that contain gravelly outwash and slope that ranges up to 18 percent. In a few areas, stones and boulders are scattered on the surface.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Lohnes, Sioux, and Sverdrup soils, and pockets of loamy fill material. Lohnes soils are moderately well drained and well drained. They differ from the Maddock soil mainly by having more gravel in the underlying material. Sioux soils are excessively drained and have more gravel throughout the profile. Sverdrup soils are somewhat excessively drained. They differ mainly by having sandy loam in the surface layer and the subsoil.

Permeability of this soil is rapid. Available water capacity is low. Organic matter content is low. Surface runoff is medium. Reaction in the surface layer is neutral.

Many areas of this soil are used as hayland and pasture. Some areas of this soil are idle, and some of these are in woodland. A few areas of this soil are cultivated, but this soil is poorly suited to crop production. Small grain is the most common crop.

A low available water capacity is the principal limitation to cropping this soil. Erosion is a concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Practices such as returning crop residue to the soil, planting field shelterbelts, and, where possible, planting on the contour hold snow cover and reduce runoff and soil blowing. These practices allow the conservation and better use of available moisture as well as control erosion. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, applying fertilizer, and controlling weeds.

This soil is best suited to growing windbreak trees and shrubs which tolerate some droughtiness. In some seasons, drought may result in moderate to severe seedling mortality.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. The severity of this hazard can be lessened by installing a larger than average drain field.

This soil is in capability subclass IVs.

46—Borup loam. This poorly drained, nearly level soil is on lake plains. It is on low, flat areas, in shallow swales, and in depressions. Individual areas of this soil are irregular in shape and typically range from 5 to 250 acres. This soil is subject to rare flooding.

Typically, the surface layer is black loam about 9 inches thick. The next layer is very strongly calcareous, mottled gray very fine sandy loam about 9 inches thick. The underlying material to a depth of about 60 inches is mottled, multicolored loamy very fine sand and very fine sandy loam. In some areas, the surface layer is silty clay loam. In places, the surface layer is thicker. In a few places, the surface layer is not calcareous. In some areas, the solum contains more fine sand.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Augsburg, Glyndon, and Wyndmere soils. Augsburg soils are on landscape positions similar to those of the Borup soil and have clayey material within 40 inches of the surface. Glyndon soils are somewhat poorly drained and moderately well drained and are on slightly higher positions. Wyndmere soils are somewhat poorly drained and moderately well drained and have a slightly sandier profile.

Permeability of this soil is moderately rapid. Both the available water capacity and the organic matter content are high. Surface runoff is very slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1.0 foot to 2.5 feet.

Nearly all the acreage of this soil is cultivated. This soil is well suited to crop production. Small grain, sugar beets, sunflowers, and potatoes are the most common crops.

Wetness is the principal limitation to cropping this soil. Soil blowing occurs in areas that have no vegetative cover. Improving and maintaining soil fertility are additional management concerns.

Constructing open field ditches reduces wetness. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate wetness and strongly calcareous soil. Seedling mortality on this soil is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants. Pruning and thinning help to establish and maintain a good stand of trees.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the flood hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, well compacted fill material and providing adequate side ditches and culverts help protect the roads from flood and frost damage.

This soil is in capability subclass IIw.

47—Colvin silty clay loam. This poorly drained, nearly level soil is on lake plains. It is on low, flat areas, in shallow swales, and in depressions. Individual areas of this soil are irregular in shape and typically range from 5 to 500 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silty clay loam about 11 inches thick. The next layer is strongly calcareous, gray silt loam and silty clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silty clay and silty clay loam. In places, the surface layer is not calcareous. In a few of these places the surface layer is silty clay. In places, strata of very fine sand and silt 1 inch to 6 inches thick are in the underlying material.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Augsburg, Fargo, and Hegne soils. Augsburg and Fargo soils are on landscapes similar to those of the Colvin soil. Hegne soils are mostly on low ridges or knobs. Augsburg soils have upper sediment that is mostly very fine sand and silt. Fargo soils have a higher clay content in the upper sediment. Hegne soils have a higher clay content in the profile.

Permeability of this soil is moderately slow or moderate. Both the available water capacity and the organic matter content are high. Surface runoff is very slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is less than 1 foot.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to crop production. Small grain, sugar beets, and sunflowers are the most common crops (fig. 4).

Wetness is the principal limitation to cropping this soil. Soil blowing may occur on cultivated areas. Improving and maintaining soil fertility is a management concern.

Constructing open field ditches reduces wetness. Delaying cultivation on wet areas until they are at the proper moisture level reduces damage to soil structure and results in more desirable seedbeds. Returning crop residue to the soil and seeding cover crops reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality on this soil is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants. Pruning and thinning help to establish and maintain a good stand of trees.

This soil is poorly suited to use as building sites because of the seasonal high water table and the flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts minimize wetness and help protect the roads from damage caused by frost action and low soil strength.

This soil is poorly suited to use as septic tank absorption fields because it has a seasonal high water table and because it does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

50—Cashel silty clay. This somewhat poorly drained, nearly level soil is on bottom lands near major streams. Individual areas of this soil are commonly elongated and

Figure 4.— Sunflowers in an area of Colvin silty clay loam.

are parallel to streams or on parts of abandoned stream channels. They typically range from 4 to 20 acres. This soil is occasionally flooded.

Typically, the surface layer is very dark gray and very dark grayish brown silty clay about 17 inches thick. The underlying material is dark grayish brown and very dark grayish brown silty clay and silty clay loam. A buried black silt loam A horizon is at a depth of about 35 inches and is about 3 inches thick. Below this to a depth of about 60 inches is dark olive gray silty clay loam that contains some shell fragments. In places, the surface layer is not calcareous. In a few areas, the surface layer is thin and organic. In some small areas, the slope is greater than 3 percent.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Fargo soils and Haplaquolls and Udifluvents. Fargo soils are in depressions and show a regular decrease in organic matter with depth. Haplaquolls and Udifluvents typically are on positions similar to those of the Cashel soil. They differ mainly by having more silty or loamy soil material.

Permeability of this soil is moderately slow to slow. Available water capacity is moderate. Organic matter content is high. This soil is subject to seasonal flooding, but flood water drains naturally from most areas. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table ranges from 1 foot to 3 feet.

Most areas of this soil are not easily accessible and are idle or used for pasture. Bottom land hardwood trees grow in many of these areas. Some areas of this soil are cultivated, and this soil is moderately suited to cropland use. The cultivated acreage of this soil is planted to small grain. Occasionally, soybeans, sunflowers, and sugar beets are grown on areas of this soil.

Flooding and inaccessibility are the principal limitations to cultivating this soil. Some areas can be protected by diking. Improving outlets from other areas removes flood water more rapidly and completely. Shaping slopes and building crossings make some areas accessible for cultivation.

This soil commonly has windbreak protection because of trees growing near the stream channels. Trees planted for windbreaks or other plantings should tolerate flood conditions. This soil is generally not well suited to conifers. Seedling mortality is commonly severe. Plant competition is severe, and equipment limitations may be severe. Weed control, cultivation, and applications of herbicides help to remove competing plants. Pruning and thinning help to establish and maintain a good stand of trees.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the flood hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by flooding and low soil strength.

This soil is in capability subclass IIIw.

52—Augsburg silt loam. This poorly drained, nearly level soil is on lake plains. It is on low, flat areas, in shallow swales, and in small depressions. Individual areas of this soil are irregular in shape and typically range from 5 to 250 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silt loam about 10 inches thick. In the next 12 inches are very strongly calcareous, gray silt loam and very fine sandy loam. The underlying material consists of mottled, light brownish gray very fine sandy loam about 9 inches thick and below that to a depth of about 60 inches olive gray silty clay and silty clay loam. Some places have a surface layer of silty clay loam. A few areas also have a surface layer of fine sandy loam.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Colvin and Wheatville soils. Colvin soils are on landscape positions similar to those of the Augsburg soil and formed mostly in silty clay loam. Wheatville soils are somewhat poorly drained and moderately well drained.

Permeability of this soil is moderately rapid in the upper loamy material and slow in the contrasting underlying clayey material. Both the available water capacity and the organic matter content are high. Surface runoff is very slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table ranges from 1 foot to 3 feet.

This soil is well suited to cropland use, and nearly all of the acreage is cultivated. Small grain, sugar beets, sunflowers, and potatoes are the most common crops.

Wetness is the principal limitation to cropping this soil. Soil blowing is a hazard on areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Returning crop residue to the soil and planting field windbreaks reduce soil blowing.

This soil is best suited to windbreak trees that tolerate wet and strongly calcareous soil. Seedling mortality is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the flood hazard. Soils that are better suited to these uses are commonly nearby. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is in capability subclass IIw.

56—Fargo silty clay loam. This poorly drained, nearly level soil is on lake plains. It is typically on flat areas and low, slightly convex ridges. Individual areas of this soil are irregular in shape and typically range from 15 to 400 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is dark grayish brown silty clay about 9 inches thick. The next layer is strongly calcareous, olive gray silty clay about 16 inches thick. The underlying material to a depth of about 60 inches is mottled, olive gray silty clay. Some places have a surface layer which is calcareous or has texture of silty clay.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Colvin and Hegne soils. Hegne soils typically differ from the Fargo soils by being on slightly higher ridges or knobs in the landscape. Colvin soils are on slightly lower landscapes. Colvin soils have strongly calcareous silty clay loam material in all soil layers. Hegne soils are more strongly calcareous at and near the surface.

Permeability of this soil is slow. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 0 to 3 feet.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Small grain, sugar beets, sunflowers, and soybeans are the most common crops.

Wetness is the principal limitation to cropping this soil. Soil blowing sometimes occurs on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Delaying cultivation until the soil is less wet allows preparation of a more desirable seedbed and improves cropping potential. Seeding cover crops and stubble mulching are the practices most commonly used to reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate soil wetness and a high water table. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts minimize the wetness limitation and help protect the roads from damage caused by low soil strength.

This soil is poorly suited to use as septic tank absorption fields because of its seasonal high water table and because of its slow permeability, which prevents it from readily absorbing effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

57A—Fargo silty clay, 0 to 2 percent slopes. This poorly drained, nearly level soil is on lake plains. It is typically on flat areas or has shallow microrelief with closely spaced slight ridges and draws. Individual areas of this soil are irregular in shape and typically range from 100 to 500 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silty clay about 12 inches thick. The subsoil is very dark gray silty clay about 12 inches thick. The next layer is strongly calcareous, olive gray silty clay about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, olive gray silty clay. Buried dark colored layers are in some places. A few areas have more clay in the profile. In places, coarse fragments are on the surface.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Colvin, Hegne, and Wahpeton soils. Colvin soils are on landscape positions similar to those of the Fargo soil and have strongly calcareous silty clay loam throughout. Hegne soils are on low ridges or knobs and have strongly calcareous layers at and near the surface. Wahpeton soils are better drained, have stronger structure, and formed in alluvial material.

Permeability of this soil is slow. Available water capacity is moderate. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is neutral. The depth to the seasonal high water table is 3 feet or less, and in some places the seasonal high water table is at the surface.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Small grain, sugar beets, sunflowers, and soybeans are the most common crops.

Wetness is the principal limitation to cropping this soil. Soil blowing may occur on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Delaying cultivation until the soil is near the optimum moisture level for cultivation allows preparation of a more desirable seedbed and improves cropping potential. Seeding cover crops and stubble mulching are the practices most commonly used to reduce soil blowing.

This soil is best suited to windbreak trees and shrubs which tolerate wetness and a high water table. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts minimize the wetness limitation and help protect the roads from damage caused by low soil strength.

This soil is poorly suited to use as septic tank absorption fields because of its seasonal high water table and because of its slow permeability, which prevents it from readily absorbing effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

57B—Fargo silty clay, 2 to 6 percent slopes. This poorly drained, gently sloping soil is on lake plains. Individual areas of this soil are elongated in shape and typically parallel major stream channels. Areas of this soil typically range from 4 to 30 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silty clay about 12 inches thick. The subsoil is very dark gray silty clay about 12 inches thick. The next layer is strongly calcareous, olive gray silty clay about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, olive gray silty clay. In places, the strongly calcareous layer is mixed with the surface layer. In places, the soil has buried dark colored layers.

Included with this soil in mapping, and making up 10 tc 15 percent of most mapped areas, are small areas of Hegne, Overly, and Wahpeton soils. Hegne soils are on landscapes similar to those of the Fargo soil and are strongly calcareous at and near the surface. Overly soils are moderately well drained and have less clay in the solum. Wahpeton soils are better drained, have stronger structure, and formed in alluvial material.

Permeability of this soil is slow. Available water capacity is moderate. Organic matter content is high. Surface runoff is medium to rapid. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 0 to 3 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain is the most common crop. Some areas of this soil are included in fields planted to sugar beets, soybeans, and sunflowers. A few areas of this soil are wooded and are used for pasture or are idle.

Wetness is the principal limitation to cropping this soil. Water in the draws and stream channels adjacent to this soil may be high enough to cause flooding. Water running off unprotected surfaces of this soil can cause the formation of rills and small gullies. Improving and maintaining soil fertility are management concerns.

Delaying cultivation until this soil is near the optimum moisture level for cultivation allows preparation of a desirable seedbed and improves cropping potential. Maintaining a vegetative cover slows runoff and reduces water erosion.

This soil is best suited to windbreak trees and shrubs which tolerate wetness and a high water table. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts minimize the wetness limitation and help protect the roads from damage caused by low soil strength.

This soil is poorly suited to use as septic tank absorption fields because of its seasonal high water table and because of its slow permeability, which prevents it from readily absorbing effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

58A—Kittson fine sandy loam, 0 to 2 percent slopes. This somewhat poorly drained and moderately well drained, nearly level soil is on lake-washed till plains. Individual areas of this soil are irregular in shape and typically range from 4 to 40 acres.

Typically, the surface layer is very dark brown fine sandy loam about 10 inches thick. The subsoil is dark grayish brown fine sandy loam about 7 inches thick. The next layer is strongly calcareous, light yellowish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is mottled, light olive brown and light olive gray loam. In places, thin bands of gravel and cobbles are in the underlying material and in the lower part of the subsoil. The surface layer is calcareous in places. In a few areas, sandy and gravelly underlying material is at a depth greater than 36 inches. Stones and boulders are on the surface in a few areas.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Flom, Foxhome, Hamerly, and Swenoda soils. Flom soils are poorly drained and typically on lower positions than the Kittson soil. Foxhome soils are moderately well drained and have a gravelly layer that is more than 6 inches thick. Hamerly soils are strongly calcareous at or near the surface. Swenoda soils are moderately well drained and are slightly sandier in the upper part.

Permeability of this soil is moderate or moderately slow. The available water capacity and the organic matter content are high. Surface runoff is slow to medium. Reaction in the surface layer is neutral. Depth to the seasonal high water table ranges from 2.5 to 6.0 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland and pasture, and a few areas are idle. Most of the idle areas support a stand of trees.

Soil blowing sometimes occurs on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns. On some areas, stones and boulders must be removed or buried so that farm machines can be operated efficiently. Seeding cover crops, stubble mulching, and planting field shelterbelts are the practices most commonly used to reduce soil blowing.

This soil is suited to most windbreak trees and shrubs that have no climatic limitation. Seedling mortality is commonly moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of this soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of its seasonal high water table and because of its moderate or moderately slow permeability, which prevents it from readily absorbing effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIc.

58B—Kittson loam, 1 to 5 percent slopes. This somewhat poorly drained and moderately well drained, nearly level and gently undulating soil is mostly on upland landscapes. A few areas are on lake-washed till plains. Individual areas are irregular in shape and typically range from 4 to 200 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is dark grayish brown and grayish brown fine sandy loam and loam about 10 inches thick. The next layer is strongly calcareous, mottled, pale brown loam about 12 inches thick. The underlying material to a depth of about 60 inches is mottled, light brownish gray loam. Bands of gravel and cobblestones or of more sandy material are in some areas. Commonly, these bands are in the lower part of the subsoil and are less than 6 inches thick. In some places, the soil has a weakly calcareous surface layer but does not have high concentrations of carbonates in the surface layer and the subsoil. In a few areas, the subsoil is less than 3 inches thick. In some areas, especially in the upland landscapes of western Cromwell Township, sandy and gravelly material is beneath the loamy till. This coarse material is typically below a depth of 36 inches. In a few areas, surface stones and boulders are numerous enough to limit operation of farm machines. In a few areas, the slope is greater than 5 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Barnes, Flom, and Hamerly soils. Barnes soils are well drained and typically are on higher positions than the Kittson soil. Flom soils are poorly drained and typically are on lower positions. Hamerly soils are somewhat poorly drained and moderately well drained and are strongly calcareous at and near the surface.

Permeability of this soil is moderate or moderately slow. Available water capacity is high. Organic matter content is high. Surface runoff is medium. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small areas are used for hayland and pasture. A few areas are idle, and most of these support a stand of trees.

Water erosion is the principal hazard to cropping this soil. Wind may remove soil from fields that have no vegetative cover. Improving and maintaining soil fertility are management concerns. In some areas, stones and boulders must be removed or buried to permit the efficient operation of farm machines. Seeding cover crops and, where possible, seeding or planting on the coutour, help to control soil erosion. In areas of concentrated water flow, grassed waterways prevent the formation of rills and gullies.

This soil is suited to most windbreak trees and shrubs that have no climatic limitation. Seedling mortality is commonly moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinkage and swelling of this soil. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of its seasonal high water table and because of its moderate or moderately slow permeability, which prevents it from readily absorbing effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

59—Grimstad fine sandy loam. This somewhat poorly drained and moderately well drained, nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 5 to 25 acres.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The next layer is strongly calcareous, very dark brown fine sandy loam about 5 inches thick. This is underlain by strongly calcareous, dark grayish brown loamy fine sand about 8 inches thick. The underlying material to a depth of about 60 inches is mottled, light yellowish brown loam. In places, the surface layer is calcareous. In some areas, thin bands of gravel and cobblestones are just above the loamy material. In a few areas, numerous stones and cobblestones are in the surface layer.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Foldahl, Rockwell, and Ulen soils. Foldahl soils are moderately well drained and have a surface layer that is sandier than that of the Grimstad soils and is noncalcareous. Rockwell soils are poorly drained and typically are on lower, concave positions. Ulen soils are on similar landscape positions and do not have contrasting loamy material within 40 inches of the surface.

Permeability of this soil is moderate. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Many areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas of this soil are used for hayland and pasture, and a few areas are idle. Most of the idle areas support a stand of trees.

A hazard of soil blowing is the principal limitation to cropping this soil. Improving and maintaining soil fertility are management concerns.

Leaving crop residue on the surface and planting field shelterbelts help to control soil blowing. These practices also help control snow blowing so more snow is held on fields, providing more moisture for plant growth. Adding barnyard manure provides protective residue and increases fertility.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping can be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIe.

60A—Glyndon loam, 0 to 2 percent slopes. This somewhat poorly drained and moderately well drained, nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 10 to 1,500 acres.

Typically, the surface layer is black loam about 10 inches thick. The next layer is very dark grayish brown loam 3 inches thick. It is underlain by a layer of very strongly calcareous, grayish brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, light yellowish brown very fine sandy loam and loamy very fine sand which grades with depth to mottled, light brownish gray very fine sand. In some places, the surface layer is thinner. In places, the very strongly calcareous underlying layer is mixed with the surface layer. Along the Sabin Ridge, the soil has a thin layer of gravelly material in the underlying material. Also, along the Sabin Ridge, the upper sediment is dominated by very fine sand and silt. This sediment grades with depth to sand or coarse sand below a depth of 40 inches. In places, thin strata of silt loam, silty clay loam, and silty clay are present, commonly below a depth of 36 inches.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Borup, Wheatville, and Wyndmere soils. Borup soils are poorly drained and are on lower, typically concave positions. Wheatville soils have contrasting clayey material within 40 inches of the surface. Wyndmere soils formed in material having less very fine sand and silt and more fine sand. Wheatville soils and Wyndmere soils typically are on similar landscapes.

Permeability of this soil is moderate. Available water capacity is high. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Nearly all of this soil is cultivated. This soil is well suited to cropland use. Small grain, sugar beets, potatoes, and sunflowers are the most common crops. A small acreage of this soil is used for corn and forage crops.

A hazard of soil blowing is the principal limitation to cropping this soil. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil and planting field shelterbelts help to control soil blowing. These practices also help control snow blowing so more snow is held on fields, providing additional moisture for plant growth.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

60B2—Glyndon loam, 2 to 6 percent slopes, eroded. This somewhat poorly and moderately well drained, gently sloping soil is on lake plains. Individual areas are elongated and commonly parallel to drains and stream channels or alluvial deposits adjacent to them. Individual areas of this soil typically range from 4 to 20 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. This is underlain by a layer of very strongly calcareous, grayish brown very fine sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is mottled, light yellowish brown very fine sand. In places, the soil has texture of silt loam throughout. In small areas, the slope is slightly over 6 percent.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Bearden, Overly, and Wheatville soils. Bearden soils have a higher content of silt and clay in the control section. Overly soils are moderately well drained and do not have free carbonates at and near the surface.

Wheatville soils have clayey material within 40 inches of the surface. Bearden, Overly, and Wheatville soils are on landscape positions similar to those of the gently sloping Glyndon soil.

Permeability of this soil is moderate. Available water capacity is high, and organic matter content is moderate. Surface runoff is medium. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Nearly all of the acreage of this soil is cultivated, and this soil is well suited to this use. Small grain is the most common crop. Some areas of this soil are included in fields planted to sugar beets, potatoes, and sunflowers.

Water erosion is the principal limitation to cropping this soil. Wind also removes soil material from areas that are dry and have no vegetative cover. Improving and maintaining soil fertility is a management concern.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour of slopes help to control erosion. In areas of concentrated water flow, grassed waterways may be needed to prevent the formation of rills and gullies.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality is moderate, and plant competition on this soil is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping can be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

61—Arveson clay loam. This poorly drained, nearly level soil is on low, flat areas, in shallow swales, and, in a few places, on slightly convex positions on lake plains. Individual areas of this soil are irregular in shape and typically range from 10 to 300 acres. This soil is subject to rare flooding.

Typically, the surface layer is black clay loam about 8 inches thick. The next layer is strongly calcareous, very dark gray clay loam about 6 inches thick. The next 11 inches is very strongly calcareous, light gray and very dark gray loam. The underlying material to a depth of about 60 inches is calcareous, gray sandy loam and loamy sand underlain by light olive gray fine sand. In some areas, stones and boulders are in the surface layer. In a few areas, the upper part of the surface layer is made up mostly of highly decomposed organic material.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Fossum, Rockwell, and Ulen soils and a few very wet seepy areas. Fossum and Rockwell soils typically are on landscapes similar to those of the Arveson soil. Fossum soils have more sand in the upper sediment and do not have a concentration of carbonates near the surface. Rockwell soils have contrasting loamy material within 40 inches of the surface. Ulen soils are somewhat poorly drained and moderately well drained and are on slightly higher, commonly convex positions.

Permeability of this soil is moderate. Available water capacity is moderate. Organic matter content is high. Surface runoff is very slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1 foot to 2 feet.

Many areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, sunflowers, and corn are the most common crops. A large acreage of this soil is also used for hayland and pasture. Some areas of this soil are idle and support grasses, sedges, and lowland brush. Scattered trees are in some of these areas.

Wetness is the principal limitation to cropping this soil. Soil blowing is a hazard where the surface has no vegetative cover. Improving and maintaining soil fertility are management concerns. Because of low available water capacity in the underlying material, this soil may be droughty during dry seasons. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, applying fertilizer, and controlling weeds.

Constructing open field ditches reduces wetness. The gradient of these ditches is critical, as flowing water erodes soil material easily. Establishing grass in the ditches reduces the formation of rills and gullies by flowing water. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate wetness and strongly calcareous soil. Seedling mortality on this soil is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and the flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIw.

63—Rockwell clay loam. This poorly drained, nearly level soil is on lake plains. It is on low, flat areas, in shallow swales, and, in some places, on slightly convex positions. Individual areas of this soil are irregular in shape and typically range from 10 to 100 acres. This soil is subject to rare flooding.

Typically, the surface layer is black clay loam about 9 inches thick. The next layers are strongly calcareous, very dark gray clay loam and dark olive gray fine sandy loam. These layers combined are about 9 inches thick. The underlying material to a depth of about 60 inches is gray fine sand and loamy fine sand over mottled, grayish brown silt loam. In places, the surface layer is not calcareous. In a few areas, the surface layer is loamy fine sand. In the underlying material in places, the part above the loamy material is mostly gravel. In some places, stones and boulders are scattered on the surface or buried just below it. In a few areas, the upper part of the surface layer is made up mostly of highly decomposed organic material.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Arveson, Grimstad, and Vallers soils and a few very wet seepy areas. Unlike the Rockwell soil, Arveson soils do not have contrasting loamy material within 40 inches of the surface. Grimstad soils are somewhat poorly drained and moderately well drained and are on slightly higher landscape positions. Valler soils do not have sandy underlying material. Arveson and Vallers soils typically are on similar landscape positions.

Permeability of this soil is moderate or moderately slow. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is very slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1 foot to 3 feet.

Many areas of this soil are cultivated. This soil is well suited to cropland use. Small grain, sunflowers, and corn are the most common crops. A large acreage is used for hay and pasture. Some areas of this soil are idle and support grasses, sedges, and lowland brush. Scattered trees are also on some of these areas.

Wetness is the principal limitation to cropping this soil. Soil blowing is a hazard where the surface has no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. The gradient of these ditches is critical, as flowing water erodes soil materials easily. Establishing grass in the ditches reduces the formation of rills and gullies by flowing water. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, fertilizing, and controlling weeds.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality on this soil is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and the flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of its seasonal high water table and because of its moderate to moderately slow permeability, which prevents it from readily absorbing effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

64—Ulen fine sandy loam. This somewhat poorly drained and moderately well drained, nearly level soil is on lake plains and alluvial fans. Individual areas of this soil are irregular in shape and typically range from 10 to 80 acres. This soil is subject to rare flooding.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The next layer is strongly calcareous, very dark gray fine sandy loam about 5 inches thick. The next layers are very strongly calcareous, dark grayish brown sandy loam that grades to grayish brown loamy fine sand. These layers are about 12 inches thick. The underlying material to a depth of about 60 inches is light olive brown loamy fine sand that grades to mottled, light yellowish brown and light brownish gray fine sand. In places, the material below the surface layer is less calcareous. In places, the underlying material has texture of very fine sand and silt loam. In a few areas, the soil has a surface layer of loam less than 8 inches thick. In a few areas, it has buried dark layers. In a few areas, the slope is slightly greater than 2 percent.

Included with this soil in mapping, and making up 5 to 15 percent of mapped areas, are small areas of Arveson, Flaming, and Fossum soils. Arveson soils are poorly drained and typically have slightly finer textures in the upper sediment than do the Ulen soils. Flaming soils are on similar landscapes and have sandier upper sediment that is noncalcareous. Fossum soils are poorly drained and commonly have slightly sandier upper sediment.

Permeability of this soil is moderately rapid. Available water capacity is moderate. Organic matter content is moderate to high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Many areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland and pasture, and a few areas are idle. Scattered trees are on most idle areas.

A hazard of soil blowing is the principal limitation to cropping this soil. This soil has moderate available water capacity and may be droughty if precipitation is less than normal or poorly distributed. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil, seeding cover crops, and planting field windbreaks help to control soil blowing (fig. 5). These practices also help to hold and distribute snow cover, providing more moisture for plant growth. Adding barnyard manure provides some protective residue and increases fertility.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Trees and shrubs used for windbreaks have a better chance of survival if they can also tolerate some drought. Seedling mortality on this soil is moderate to high, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and the flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, well compacted fill material

Figure 5.— Single row shelterbelt on Ulen fine sandy loam.

and providing adequate side ditches and culverts help protect the roads from flood and frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIe.

65—Foxhome fine sandy loam. This moderately well drained, nearly level soil is on lake-washed till plains. Individual areas of this soil are irregular in shape and typically range from 5 to 50 acres.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The subsoil is very dark grayish brown loamy sand which grades to grayish brown loamy sand. It is about 8 inches thick. The underlying material is grayish brown very gravelly loamy coarse sand in the upper 9 inches. Below that to a depth of 60 inches it is mottled, light brownish gray fine sandy loam. In places, the surface layer is calcareous. In some areas, the gravelly layer is less than 6 inches thick. In some areas, stones and boulders are scattered on the surface or buried just below it. In few small areas, the slope is slightly greater than 3 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Kittson, Foldahl, and Lohnes soils. Kittson soils are somewhat poorly drained and moderately well drained and do not have a coarse textured, gravelly layer more than 6 inches thick. Foldahl soils have a slightly coarser textured surface layer and less gravelly material underlying it. Kittson and Foldahl soils are on landscapes similar to those of the Foxhome soil. Lohnes soils are moderately well drained and well drained, have a slightly coarser textured surface layer, and do not have contrasting finer textured material within 40 inches of the surface. Well drained Lohnes soils are on higher areas, typically ridges. Moderately well drained Lohnes soils are on similar drainage positions, but are on beach or interbeach areas.

Permeability of this soil is moderate. Available water capacity is moderate. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Most areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas of this soil are in hayland and pasture, and some areas are idle. The idle areas support native and introduced grasses, and scattered trees are on some of these areas.

During periods of limited or poorly distributed rainfall, this soil may be droughty. The gravel layer in this soil may limit root development and penetration. Soil blowing sometimes occurs on cultivated areas that have no vegetative cover. Stones and boulders may have to be removed from some areas so that farm machines can be operated efficiently. Improving and maintaining soil fertility are additional management concerns.

Returning crop residue to the soil, seeding cover crops, and planting field windbreaks help to control soil blowing. These practices also hold and distribute snow cover, providing additional moisture for plant growth.

This soil is best suited to windbreak trees and shrubs which tolerate some drought. Seedling mortality is slight to moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIs.

66—Flaming fine sand. This somewhat poorly and moderately well drained, nearly level soil is on lake plains and alluvial fans. Individual areas of this soil are irregular in shape and typically range from 10 to 200 acres.

Typically, the surface layer is very dark brown fine sand about 13 inches thick. The subsoil, about 22 inches thick, is very dark grayish brown fine sand grading with depth to mottled, dark brown and brown fine sand. The underlying material to a depth of about 60 inches is mottled, light brownish gray fine sand. In places, the soil is calcareous throughout. In some places, it has a dark surface layer that may be as thick as 24 inches. In some areas, thin gravel layers are in the profile. In a few areas, the soil has layers of concentrated carbonates, but these are typically below a depth of 20 inches. In some small areas, the slope is slightly greater than 3 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Fossum, Poppleton, and Ulen soils. Fossum soils are poorly drained and are on lower positions on the landscape than the Flaming soil. Poppleton soils have a thinner dark surface layer. Ulen soils have a slightly finer textured surface layer that is more strongly calcareous. Poppleton soils are on similar landscapes, and Ulen soils are on slightly lower landscape positions.

Permeability of this soil is rapid. Available water capacity is low. Organic matter content is moderate. Surface runoff is slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 2.5 to 6.0 feet.

A large acreage of this soil is used for hayland and pasture. This soil is poorly suited to crop production; however, some areas of this soil are cultivated. Small grain, sunflowers, and corn are the most common crops. Some areas of this soil are idle and support native and introduced grasses, weeds, and forbs. Other idle areas are in woodland.

A hazard of soil blowing is the principal limitation to cropping this soil. The low available water capacity and medium inherent fertility limit productivity.

Leaving crop residue on the surface, growing cover crops, and planting field windbreaks help to control soil blowing. These practices also help control snow blowing so more snow is held on fields, providing more moisture for plant growth. Adding barnyard manure provides some protective residue and increases fertility. Production of hay and pasture crops can be increased by rotating pasture, delaying grazing, adding fertilizer, and controlling weeds.

This soil is best suited to windbreak trees and shrubs which tolerate some drought. Seedling mortality is moderate to severe, and plant competition is commonly slight.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IVe.

67A—Bearden silt loam, 0 to 2 percent slopes. This somewhat poorly drained, nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 15 to 320 acres (fig. 6).

Typically, the surface layer is black silt loam about 9 inches thick. The next layer is very strongly calcareous, grayish brown and brown silt loam about 15 inches thick. The underlying material to a depth of about 60 inches is brown and mottled, grayish brown silt loam. In places, the surface layer is silty clay loam. Also, in places, the soil has strata of silty clay, typically at a depth greater than 36 inches. In some areas, layers of very fine sandy loam and loamy very fine sand are below the surface layer. In a few areas, the soil has buried dark layers. In some areas, coarse fragments are scattered on the surface and in the upper soil material. In a few areas, the surface layer is noncalcareous.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Colvin, Overly, and Wheatville soils. Colvin soils are poorly drained and typically are on slightly lower landscape positions than the Bearden soils. Overly soils typically are on similar landscape positions, are moderately well drained, and are noncalcareous in the surface layer and the subsoil. Wheatville soils are on similar landscapes, are somewhat poorly drained and moderately well drained, and differ from the Bearden soil by having mostly very fine sand with contrasting layers of silty clay or clay within 40 inches of the surface.

Permeability of this soil is slow to moderate. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1.5 to 2.5 feet.

Nearly all of the acreage of this soil is cultivated, and this soil is well suited to cropland use. Small grain, sugar beets, sunflowers, and potatoes are the most common crops (fig. 7).

A hazard of soil blowing is the principal limitation to cropping this soil. Improving and maintaining soil fertility are additional management concerns.

Returning crop residue to the soil and planting field shelterbelts help to control soil blowing. These practices also help to hold and distribute snow cover, providing additional moisture for plant growth.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of this soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by the low strength of the soil and frost action in the soil.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

67B2—Bearden silt loam, 2 to 6 percent slopes, eroded. This somewhat poorly and moderately well drained, gently sloping soil is on lake plains. Individual areas of this soil are elongated and commonly parallel drains and stream channels or alluvial deposits adjacent

Figure 6.— Field of Bearden silt loam, 0 to 2 percent slopes, ready for spring planting.

to them. Individual areas of this soil typically range from 4 to 20 acres.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The next layer is very strongly calcareous, grayish brown silt loam about 16 inches thick. The underlying material to a depth of about 60 inches is mottled, pale brown silt loam. In places, the surface layer has been mixed with the very strongly calcareous underlying material. In places, the surface layer is silty clay loam or silty clay and is grayer. In some

Figure 7.— Sugar beets in an area of Bearden silt loam, 0 to 2 percent slopes.

areas, clay underlies the more silty upper material. In a few areas, the soil has layers of mostly very fine sand that are 2 to 6 inches thick. In a few areas, it has slope slightly greater than 6 percent.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Overly and Wheatville soils. Overly soils are moderately well drained and are noncalcareous in the surface layer and the subsoil. Wheatville soils have layers of silty clay or clay within 40 inches of the surface. Overly and Wheatville soils are on landscape positions similar to those of the Bearden soil.

Permeability of this soil is slow to moderate. Available water capacity is high. Organic matter content is moderate. Surface runoff is medium. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1.5 to 2.5 feet.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Small grain is the most common crop. Some areas of this soil are included in fields planted to sugar beets, sunflowers, and potatoes.

Water erosion is the principal limitation to cropping this soil. Wind also removes soil from areas that are dry and have no vegetative cover. Improving and maintaining soil fertility are additional management concerns.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour help to control erosion. In areas of concentrated water flow, grassed waterways may be needed to prevent the formation of rills and gullies.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping can be designed to drain surface water away from buildings. Foundations and footings can be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by the low strength of the soil and frost action in the soil.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

68—Arveson clay loam, depressional. This very poorly drained, nearly level soil is in depressions, swales, and draws on lake plains. Individual areas of this soil are irregular in shape and typically range from 3 to 60 acres. This soil is subject to rare flooding and ponding.

Typically, the surface layer is strongly calcareous, very dark gray clay loam about 8 inches thick. The next layer is strongly calcareous, very dark gray loam and silt loam about 6 inches thick. The next main layer is very strongly calcareous, mottled, light gray loam about 20 inches thick. The underlying material to a depth of about 60 inches is mottled, gray sandy loam. In some areas, thin deposits of silty sediment are on the surface or in the profile. In some areas, the soil has a thick surface layer or buried dark layers. In some places, there is a layer of 10 to 20 inches of sandy loam over sand, and in other areas, loam is throughout the upper 40 inches. In a few areas, stones are on the surface and in the profile. Thin, highly decomposed organic layers are on the surface in a few areas.

Included with this soil in mapping, and making up 3 to 15 percent of most mapped areas, are small areas of Markey muck and Rockwell depressional soils. Unlike the Arveson soil, Markey soils have more than 16 inches of organic material over sand. Rockwell depressional soils have loamy textures underlying more sandy soil material.

Permeability of this soil is moderate. Available water capacity is moderate. Organic matter content is high. Surface runoff on most areas is ponded. Reaction in the surface layer is moderately alkaline. The seasonal high water table is above 1 foot.

A large acreage of this soil is used as hayland and pasture. This soil is moderately suited to these uses. Much of the acreage of this soil is idle and supports sedges, grasses, and lowland brush. A few areas are wooded. A few areas of this soil are included in fields that are cultivated and are planted to crops such as small grain, sunflowers, and corn. These areas provide good habitat for wetland wildlife.

Wetness is the principal limitation to cropping this soil. Some ponding from runoff commonly results, even though ditches are constructed to remove excess water. Soil blowing is a hazard when this soil is dry and not vegetated. The low available water capacity of the underlying material may cause this soil to be droughty during dry seasons.

Constructing open field ditches reduces wetness. The gradient of these ditches is critical, as flowing water erodes soil material easily. Establishing grass in the ditches reduces the formation of rills and gullies by flowing water. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, applying fertilizer, controlling weeds, and constructing drainage systems.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the flood hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, well compacted fill material and providing adequate side ditches and culverts help protect the roads from flood and frost damage.

This soil is in capability subclass IVw.

71—Fossum loamy sand. This poorly drained, nearly level soil is in shallow swales on lake plains. Individual areas of this soil are irregular in shape and typically range from 15 to 80 acres. This soil is subject to rare flooding.

Typically, the surface layer is black loamy sand about 10 inches thick. The next layer is strongly calcareous, dark gray loamy fine sand. This layer is about 8 inches thick. The underlying material to a depth of about 60 inches is mottled, light brownish gray and olive gray fine sand grading with depth to mottled, pale olive fine sand. In some areas, the surface layer is fine sandy loam that is typically less than 9 inches thick. In places, the underlying material is gravelly. In some areas, only the surface layer is calcareous. In other areas the material within 40 inches is not calcareous. In a few areas, stones are on the surface and in the profile.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Arveson, Flaming, and Rockwell soils. Arveson soils have finer textured, more strongly calcareous upper sediment. Flaming soils are on landscapes that are slightly higher and more convex than that of the Fossum soil, are somewhat poorly drained and moderately well drained, and are noncalcareous in the upper sediment. Rockwell soils have contrasting loamy material within 40 inches of the surface. Arveson and Rockwell soils typically are on similar landscape positions.

Permeability of this soil is rapid. Available water capacity is low. Organic matter content is high. Surface runoff is very slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 1.0 foot to 2.5 feet.

A large acreage of this soil is used for hayland and pasture, and this soil is moderately suited to these uses. Other areas of this soil are idle and support grasses, sedges, and lowland brush. Scattered trees are in a few areas. Some areas of this soil are cultivated; however, this soil is poorly suited to cropland use. Small grain, sunflowers, and corn are the most common crops.

Wetness is the principal limitation to cropping this soil. Soil blowing is a hazard in areas where the surface has no vegetative cover. Improving and maintaining soil fertility are management concerns. Because of a low available water capacity, this soil may be droughty during dry seasons.

Constructing open field ditches reduces wetness. The gradient of these ditches is critical, as flowing water erodes soil easily. Establishing grass in the ditches reduces the formation of rills and gullies by flowing water. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, fertilizing, and controlling weeds.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality on this soil is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicide help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and the flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, well compacted, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by flooding, soil wetness, and frost action.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity of this soil may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IVw.

93—Bearden silty clay loam. This somewhat poorly drained and nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 15 to 500 acres.

Typically, the surface layer is black silty clay loam about 12 inches thick. The next layer is very strongly calcareous, grayish brown silty clay loam about 12 inches thick. This grades to strongly calcareous, mottled, grayish brown silt loam about 7 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silty clay loam grading with depth to mottled, grayish brown and light gray silt loam. In some areas, the soil has a surface texture of silt loam. In places, silty clay layers are below 36 inches. In some areas, layers of very fine sandy loam and loamy very fine sand are below the surface layer. These underlying layers are commonly 2 to 6 inches thick, but they may be thicker below a depth of 40 inches. In a few areas, the soil has a noncalcareous surface layer but is calcareous within 16 inches of the surface.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Colvin, Fargo, Overly, and Wheatville soils. Colvin soils are poorly drained and typically are on slightly lower landscape positions than those of the Bearden soil. The Fargo soils are on slightly lower positions, are poorly drained, and are finer textured and less calcareous in the upper part. Overly soils are moderately well drained and are noncalcareous in the surface layer and the subsoil. Wheatville soils have contrasting silty clay or clay layers within 40 inches of the surface. Overly and Wheatville soils typically are on similar landscapes.

Permeability of this soil is slow to moderate. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1.5 to 2.5 feet.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Small grain, sugar beets, and sunflowers are the most common crops.

A hazard of soil blowing is the principal limitation to cropping this soil. Improving and maintaining soil fertility are additional management concerns.

Conservation practices, such as returning crop residue to the soil and planting field shelterbelts, help to control soil blowing. These practices also help to hold and distribute snow cover, providing additional moisture for plant growth. Delaying cultivation until the moisture content of the surface is near the optimum level for cultivation reduces compaction and damage to soil structure and allows the preparation of a more desirable seedbed.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of this soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by low strength and frost action.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

127B—Sverdrup sandy loam, 1 to 4 percent slopes. This somewhat excessively drained, nearly level and gently sloping soil is on outwash plains in the uplands. Individual areas of this soil are irregular in shape and typically range from 5 to 70 acres.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is about 12 inches thick. It is dark brown sandy loam in the upper 7 inches and dark brown loamy sand in the lower part. The underlying material to a depth of about 60 inches is multicolored fine sand and loamy sand grading with depth to pale brown and light gray sand. In places, the underlying material is mottled. In some areas, it has finer texture, and in some small areas it has gravelly layers.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Maddock and Swenoda soils. Maddock soils typically are on slightly higher landscapes than the Sverdrup soil, are well drained, and have sandier material in the surface layer and the subsoil. Swenoda soils are on similar landscapes, are moderately well drained, and have loamy underlying material.

Permeability of this soil is moderately rapid in the loamy upper part and rapid in the sandy underlying material. Available water capacity is low. Organic matter content is moderate. Surface runoff is slow. Reaction in the surface layer is neutral.

Many areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland or pasture. A few areas are idle, and some of these are wooded.

Low available water capacity is the principal limitation to cropping this soil. Soil blowing is also a concern in cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Conservation tillage, which leaves crop residue on the soil, and planting field shelterbelts hold snow cover and reduce the drying effect of wind, thereby allowing the conservation and better use of available water. These practices also help to control soil blowing. Adding barnyard manure provides some protective residue and increases fertility. If water is available, irrigation may be considered to assure adequate moisture for plant growth.

This soil is best suited to growing windbreak trees and shrubs that tolerate some drought. In some seasons, droughty conditions may result in moderate to severe seedling mortality.

This soil is well suited to use as building sites and as sites for local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. The severity of this hazard can be lessened by installing a larger than average drain field.

This soil is in capability subclass IIIs.

127C—Sverdrup sandy loam, 4 to 12 percent slopes. This somewhat excessively drained, gently sloping and sloping soil is on outwash plains in the uplands. Individual areas of this soil are irregular in shape and typically range from 5 to 90 acres.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is about 10 inches thick. It is dark brown sandy loam in the upper 6 inches and dark brown loamy sand in the lower part. The underlying material to a depth of about 60 inches is yellowish brown fine sand which grades to pale brown and light gray sand. In a few areas the underlying material is mottled, typically below a depth of 36 inches. In some areas the underlying material has finer texture. In a few areas the surface layer and subsoil consist of fine sandy loam, loam, and silt loam. In some areas, gravelly layers are in the underlying material. In a few small areas, slopes are slightly greater than 12 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Maddock, Sioux, and Swenoda soils. Maddock soils are well drained and have sandier material in the surface layer and subsoil than does the Sverdrup soil. Sioux soils are excessively drained and have gravelly underlying material. Swenoda soils are moderately well drained and have loamy underlying material. On these slopes, Maddock and Sioux soils are on landscape positions similar to Sverdrup soils. Swenoda soils are typically slightly lower and less sloping.

Permeability of this soil is moderately rapid in the loamy upper part and rapid in the sandy underlying material. Available water capacity is low. Organic matter content is moderate. Surface runoff is medium. Reaction in the surface layer is neutral.

Most areas of this soil are used for hayland or pasture or are idle. This soil is poorly suited to crop production. A low available water capacity is the principal limitation to cropping this soil. Erosion by wind and water is a concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Practices such as returning crop residue to the soil, conservation tillage, planting field shelterbelts, and, where possible, planting on the contour hold snow cover and reduce runoff and soil blowing. These practices allow the conservation and better use of available moisture, as well as helping to control erosion. Adding barnyard manure provides some protective residue and increases fertility. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, adding fertilizer, and controlling weeds.

This soil is best suited to windbreak trees and shrubs that tolerate some drought. In some seasons, droughty conditions may cause moderate to severe seedling mortality.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. The severity of this hazard can be lessened by installing a larger than average drain field.

This soil is in capability subclass IVe.

148—Poppleton fine sand. This somewhat poorly and moderately well drained, nearly level soil is on lake plains and alluvial fans. Individual areas of this soil are irregular in shape and typically range from 10 to 300 acres.

Typically, the surface layer is very dark brown fine sand about 8 inches thick. The subsoil is dark brown and brown sand and fine sand grading to mottled, pale brown and grayish brown fine sand. This layer is about 23 inches thick. The underlying material to a depth of about 60 inches is mottled, light brownish gray fine sand. In some areas, all parts just below the surface layer are weakly calcareous. In some areas, the surface layer is thin and has a fine sandy loam or sandy loam texture. In a few areas, the underlying material is as much as 5 percent gravel. In some small areas, the slope is greater than 2 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Flaming, Fossum, and Foldahl soils. Flaming soils are on landscapes similar to those of the Poppleton soil and have a thicker dark colored surface layer. Fossum soils are on lower positions, are poorly drained, and are calcareous at and near the surface. Foldahl soils are on similar landscapes, are moderately well drained, and have loamy material within 40 inches of the surface.

Permeability of this soil is rapid. Both the available water capacity and the organic matter content are low. Surface runoff is slow. Reaction in the surface layer is medium acid. Depth to the seasonal high water table is 2.5 to 5.0 feet.

A large acreage of this soil is used for hayland and pasture. This soil is moderately suited to these uses. Other areas are idle and support native and introduced grasses, weeds, and forbs. Some areas of this soil are cultivated, but this soil is poorly suited to crop production. Small grain, sunflowers, and corn are the most common crops.

Low available water capacity, low inherent fertility, and a hazard of soil blowing are the principal limitations to cropping this soil.

Leaving crop residue on the surface, planting cover crops, conservation tillage, and planting field windbreaks help to control soil blowing. These practices also help control snow blowing so more snow is held on fields, providing more moisture for plant growth. If a water supply is available, irrigation may be considered to insure adequate moisture. Adding barnyard manure provides some protective residue and increases fertility. Production of hay and pasture crops can be increased by rotating pasture, delaying grazing, applying fertilizer, and controlling weeds.

This soil is best suited to windbreak trees and shrubs that tolerate some drought. Seedling mortality is moderate to severe, and plant competition is commonly slight.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping can be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IVs.

157A—Wahpeton silty clay, 0 to 2 percent slopes. This moderately well drained, nearly level soil is on lake plains, commonly on levee-like or terrace-like positions near major streams. Areas of this soil are irregular in shape and typically are oriented in a northwest-southeast direction. These areas typically range from 10 to 700 acres.

Typically, the surface layer is black silty clay about 13 inches thick. The subsoil is very dark grayish brown silty clay about 21 inches thick. The next layer is mottled, grayish brown silty clay loam about 7 inches thick. This is underlain by a layer of very dark gray silty clay about 7 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silty clay. Some areas do not have a buried dark colored layer. Some areas of this soil have a thinner surface layer and subsoil.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Fargo and Overly soils. Fargo soils typically are on lower landscapes than the Wahpeton soil, are poorly drained, have weaker structure, and show a regular decrease in organic matter. Overly soils are on similar positions and formed in more silty soil materials.

Permeability of this soil is moderate to moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is slow to medium. Reaction in the surface layer is slightly acid.

Nearly all of the acreage of this soil is cultivated, and this soil is well suited to cropland use. Small grain, sugar beets, sunflowers, and soybeans are the most common crops. A few small areas near streams are wooded.

The high clay content is the main limitation to cultivating this soil. Working this soil when it is wet damages its structure and makes seedbed preparation difficult. In some areas of this soil, occasional flooding delays cultivation or drowns crops. Soil blowing sometimes occurs on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Delaying cultivation until the surface soil is near the optimum moisture level for cultivation allows preparation of a more desirable seedbed and improves cropping potential. Seeding cover crops and stubble mulching are the practices most commonly used to reduce soil blowing. Open field ditches may be required on some areas of this soil to remove excess water.

This soil is best suited to windbreak trees and shrubs that grow well on fine textured soils. Seedling mortality on this soil is moderate to low, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the flood hazard and the structural damage that may result from shrinking and swelling of the soil with changes in moisture content. If buildings are constructed on this soil, they should be built on sites raised with well compacted, coarse textured fill material. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling. Backfilling around foundations with suitable coarse material provides additional protection against damage to structures. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to protect the roads from damage caused by flooding, low soil strength, and frost action.

This soil is generally not suited to use as septic tank absorption fields because of the flood hazard and because the soil does not readily absorb effluent. Soils that are better suited to this use are commonly nearby.

This soil is in capability subclass IIs.

157B—Wahpeton silty clay, 2 to 6 percent slopes. This moderately well drained, gently sloping soil is on lake plains. Areas of this soil are elongated in shape and typically parallel to major natural drains and stream channels. Individual areas typically range from 4 to 30 acres.

Typically, the surface layer is very dark brown silty clay about 10 inches thick. The subsoil is very dark grayish brown silty clay about 20 inches thick. This is underlain by a layer of very dark brown silty clay about 8 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silty clay. Some areas do not have a buried dark colored layer. In some areas, part of the subsoil is mixed with the surface layer. In a few areas, less clay is below the subsoil.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Fargo and Overly soils. Fargo soils are poorly drained, typically have weaker structure than the Wahpeton soil, and show a regular decrease in organic matter. Overly soils formed in more silty soil material and commonly are on similar landscape positions.

Permeability of this soil is moderate to moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is medium. Reaction in the surface layer is slightly acid.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain is the most common crop. Some areas of this soil are included in fields planted to sugar beets, soybeans, and sunflowers. A few areas of this soil are wooded and are used for pasture or are idle.

Water erosion is the principal limitation to cropping this soil. The level of water in the draws and stream channels adjacent to this soil may be high enough to cause flooding. Improving and maintaining soil fertility are additional management concerns.

Erosion can be reduced by cultivating and planting on the contour and by maintaining vegetative cover on this soil. Grassed waterways prevent the formation of rills and gullies in areas of concentrated flow. Delaying cultivation until the surface layer is no longer wet helps prevent damage to the structure of the soil.

This soil is best suited to windbreak trees and shrubs that grow well on fine textured soils. Seedling mortality on this soil is moderate to low, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the flood hazard and the structural damage that may result from shrinking and swelling of the soil with changes in moisture content. If buildings are constructed on this soil, they should be built on sites raised with well compacted, coarse textured fill material. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling. Backfilling around foundations with suitable coarse material provides additional protection against damage to structures. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to protect the roads from damage caused by flooding, low soil strength, and frost action.

This soil is generally not suited to septic tank absorption fields because of the flood hazard and because the soil does not readily absorb effluent. Soils that are better suited to this use are commonly nearby.

This soil is in capability subclass IIe.

157C—Wahpeton silty clay, 6 to 12 percent slopes. This moderately well drained, sloping soil is on lake plains. Areas of this soil are elongated in shape and typically parallel to major natural drains and stream channels. Individual areas typically range from 4 to 20 acres.

Typically, the surface layer is very dark brown silty clay about 10 inches thick. The subsoil is very dark grayish brown silty clay about 20 inches thick. It is underlain by a layer of very dark brown silty clay about 4 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silty clay. In some areas, the soil does not have buried, dark colored layers. In some areas, the surface layer is moderately eroded. In a few areas, the soil materials below the subsoil contain less clay.

Included with this soil in mapping, and making up 5 to 10 percent of most mapped areas, are small areas of Fargo and Overly soils. Fargo soils are poorly drained, typically have weaker structure than the Wahpeton soil, and show a regular decrease in organic matter content with depth. They are in lower lying positions. Overly soils are moderately well drained, formed in more silty soil material, and are on similar landscapes.

Permeability of this soil is moderate to moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is medium. Reaction in the surface layer is slightly acid.

Some areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain is the most common crop. Small areas of this soil are included in fields planted to sugar beets, soybeans, and sunflowers. Some areas of this soil are wooded and are used for pasture or are idle.

Soil erosion by water is the principal limitation to cropping this soil. The level of water in the draws and stream channels adjacent to this soil may be high enough to cause flooding. Improving and maintaining soil fertility are management concerns.

Conservation practices, such as planting on the contour and maintaining vegetative cover, reduce water erosion. Grassed waterways prevent the formation of rills and gullies in areas of concentrated flow. Delaying cultivation until the surface layer is no longer wet helps prevent damage to the structure of the soil.

This soil is best suited to windbreak trees and shrubs that grow well on fine textured soils. Seedling mortality on this soil is moderate to low, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the flood hazard, and structural damage may result from shrinking and swelling of the soil with changes in moisture content. If buildings are constructed on this soil, they should be built on sites raised with well compacted, coarse textured fill material. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent damage to structures caused by shrinking and swelling. Backfilling around foundations with suitable coarse material provides additional protection against structural damage. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by flooding, low soil strength, and frost action.

This soil is generally not suited to use as septic tank absorption fields because of the flood hazard and because the soil does not readily absorb effluent. Soils that are better suited to this use are commonly nearby.

This soil is in capability subclass IIIe.

180B—Gonvick clay loam, 1 to 4 percent slopes. This moderately well drained, nearly level and gently undulating soil is on upland landscapes. Individual areas of this soil are irregular in shape and typically range from 3 to 50 acres.

Typically, the surface layer is black clay loam about 11 inches thick. The subsoil is brown clay loam which grades to mottled, olive brown sandy clay loam as depth increases. This layer is about 11 inches thick. The next layer is strongly calcareous, mottled, grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown loam. Some areas have a clayey surface layer. Stones and boulders are on the surface in some areas. In some areas, sand and gravel may occur at a depth greater than 36 inches.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Flom and Waukon soils. Flom soils are poorly drained and are on lower landscape positions than the Gonvick soils. Waukon soils are well drained and are on slightly higher positions.

Permeability of this soil is moderate. Both the available water capacity and the organic matter content are high. Surface runoff is medium. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland and pasture. Other areas are in woodland, and most of these are idle.

Water erosion is the principal limitation to cropping this soil. Wind sometimes removes soil from fields that have no vegetative cover. Improving and maintaining soil fertility are management concerns. On some areas, stones and boulders restrict the operation of farm machinery. Working this soil when it is wet damages soil structure and results in a cloddy surface.

Seeding cover crops, and, where possible, planting on the contour help to control wind and water erosion. In areas of concentrated water flow, grassed waterways prevent the formation of rills and gullies. Delaying cultivation until the surface is near the optimum moisture level for cultivation reduces damage to the structure of the soil.

This soil is suited to most windbreak trees and shrubs that have no climatic limitation. Seedling mortality is commonly moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Backfilling around foundations with suitable coarse material provides additional protection against structural damage. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

184B—Hamerly loam, 1 to 4 percent slopes. This somewhat poorly and moderately well drained, nearly level and gently undulating soil is on upland and lake-washed till landscapes. Individual areas of this soil are irregular in shape and typically range from 10 acres to 700 acres.

Typically, the surface layer is black loam about 10 inches thick. This is underlain by very strongly calcareous, dark grayish brown and pale brown loam about 20 inches thick. The underlying material to a depth of about 60 inches is mottled, light brownish gray loam. Some areas have a surface layer that is less than 7 inches thick and more grayish in color. In these areas, part of the very strongly calcareous material is commonly mixed with the surface layer. Some areas have layers of sand or sandy and gravelly material underlying the loamy materials at a depth of more than 30 inches. In some areas, the dark colored surface layer is more than 16 inches thick. In a few areas, the surface layer is noncalcareous, but calcareous material is within 16 inches of the surface.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Divide, Kittson, Flom, and Vallers soils. Divide soils are on landscapes similar to those of the Hammerly soil and have a significant layer of gravelly material, commonly within 30 inches of the surface. Kittson soils also are on similar landscapes and are noncalcareous in the surface layer and upper part of the subsoil. Flom soils are on lower landscapes, are poorly drained, and are typically noncalcareous at and near the surface. Vallers soils are poorly drained and also are on lower landscape positions.

Permeability of this soil is moderate to moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is medium to slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2 to 4 feet.

Most areas of this soil are cultivated, and this soil is well suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland and pasture. A few areas are idle, and these support trees or are in native and introduced grasses. Some scattered brush is commonly on these areas.

Water erosion is the principal limitation to cropping this soil. Soil blowing may occur on fields that have no vegetative cover. Improving and maintaining soil fertility are additional management concerns. In some areas, stones and boulders must be removed or buried so that farm machines can be operated efficiently. Seeding cover crops, stubble mulching, and cultivating on the contour help to control soil blowing and water erosion. In areas of concentrated flow, grassed waterways prevent the formation of rills and gullies.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicide help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Backfilling around foundations with suitable coarse material provides additional protection against damage to structures. Constructing roads on raised, well compacted fill material and providing adequate side ditches and culverts help protect the roads from flood and frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

236—Vallers loam. This poorly drained, nearly level soil is on upland and lake-modified till landscapes. Individual areas of this soil are irregular in shape and typically range from 3 to 700 acres. This soil is subject to rare flooding.

Typically, the surface layer is black loam about 9 inches thick. The next layer is strongly calcareous, very dark gray loam about 4 inches thick. The material below that is very strongly calcareous, gray clay loam about 13 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is mottled, olive gray loam. In some areas, part of the very strongly calcareous, gray material is mixed with the surface soil. This results in a more grayish surface color which is especially evident when the surface is dry. In some areas, the underlying material contains bands of gravel and sand that are typically less than 6 inches thick. In some areas, the soil has a dark colored surface layer more than 24 inches thick. In a few areas, numerous stones and boulders are on the surface and buried in the upper soil material.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Flom, Hamerly, and Rockwell soils. Flom soils are on positions similar to those of the Vallers soils and are noncalcareous in the surface soil and the subsoil. Hamerly soils are somewhat poorly drained and moderately well drained and typically are on slightly higher, more convex positions. Rockwell soils are on similar positions and have a sandy layer more than 6 inches thick above underlying loamy material.

Permeability of this soil is moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1.0 foot to 2.5 feet.

Many areas of this soil are cultivated, and this soil is well suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland and pasture. Other areas are idle and support wetland grasses, sedges, lowland brush, and some areas of trees.

Wetness is the principal limitation to cropping this soil. Most of the excess water can be removed by constructing open field ditches and deepening and widening natural water courses. Soil blowing may occur on fields that have no vegetative cover. Stubble mulching and seeding cover crops help to control soil blowing. Improving and maintaining soil fertility are management concerns. In some areas, stones and boulders must be removed or buried so that farm machines can be operated efficiently.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table and flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

245B—Lohnes coarse sandy loam, 1 to 6 percent slopes. This well drained, nearly level and gently sloping soil is on the crests and upper side slopes of ridges on lake plains and uplands. Individual areas of this soil are irregular in shape and typically range from 10 to 300 acres.

Typically, the surface layer is black coarse sandy loam about 9 inches thick. The subsoil is very dark grayish brown gravelly loamy coarse sand about 7 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and light yellowish brown gravelly coarse sand and coarse sand. A few areas have a loamy surface layer and subsoil and have sand and gravel in the underlying material. In places, contrasting loamy material underlies the sand and gravel, typically at a depth greater than 36 inches. In a few areas, stones and boulders are scattered on the surface and buried in the upper part of the profile. Some small areas have slopes slightly greater than 6 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Maddock and Sioux soils. Maddock soils do not have significant amounts of gravel and coarse sand in the underlying material. Sioux soils are excessively drained and have more gravel in the underlying material than does the Lohnes soil. Maddock and Sioux soils commonly are on similar landscapes along beach deposits.

Permeability of this soil is rapid. Available water capacity is low. Organic matter content is moderate. Surface runoff is slow to medium. Reaction in the surface layer is neutral.

Most areas of this soil are used for hayland and pasture, and this soil is moderately suited to these uses. Other areas, which are idle, support introduced and native grasses and, in some places, trees or brush. Some areas of this soil have been or are presently used as a source of sand and gravel for roadbuilding, road surfacing, and other construction uses.

Low available water capacity is the principal limitation to cropping this soil. Soil blowing is also a concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Practices such as returning crop residue to the soil and planting field shelterbelts hold snow cover and reduce the drying influence of wind, thereby allowing the conservation and better use of available water. These practices also help to control soil blowing. Adding barnyard manure provides some protective residue and increases fertility. If water is available, irrigation may be considered to assure adequate moisture for plant growth. Applying fertilizers based on soil tests improves crop production. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, applying fertilizer, and controlling weeds.

The growth of windbreak trees is severely limited on this soil. Seedling mortality is severe on this soil. Onsite inspection can help to determine which species to plant and the proper management practices to follow.

This soil is suited to use as sites for buildings and local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing distribution lines as close to the surface as possible lessens the severity of this hazard.

This soil is in capability subclass IVs.

293B—Swenoda sandy loam, 1 to 4 percent slopes. This moderately well drained, nearly level and gently sloping soil is on lake plain and lake washed till landscapes. Individual areas of this soil are irregular in shape and typically range from 4 to 80 acres.

Typically, the surface layer is black sandy loam about 13 inches thick. The subsoil is about 19 inches thick. It is very dark brown sandy loam in the upper 11 inches and mottled, brown loamy sand in the lower part. The underlying material to a depth of about 60 inches is mottled, grayish brown loam. In some areas, the depth to the underlying material is less than 16 inches. Some areas have a sandy layer over the underlying material. In a few areas, the underlying material is silty. In some areas, stones are scattered throughout the profile. Some small areas have slopes slightly greater than 4 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Foldahl, Kittson, and Sverdrup soils. Foldahl soils have sandier upper sediment and a thinner, dark colored surface layer. Kittson soils are somewhat poorly drained and moderately well drained and do not have sandy loam or sandier texture in the upper part of the profile. Sverdrup soils are somewhat excessively drained and have sandy underlying material. Foldahl and Kittson soils are commonly on landscape positions similar to those of the Swenoda soil. Sverdrup soils are on slightly higher landscape positions.

Permeability of this soil is moderately rapid in the upper sediment and moderate to moderately slow in the underlying materials. Available water capacity is moderate. Organic matter content is high. Surface runoff is slow to medium. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 2.5 to 4.0 feet.

Many areas of this soil are cultivated, and this soil is moderately suited to cropland use. Small grain, corn, sunflowers, and soybeans are the most common crops. Some areas are used for hayland and pasture. A few areas are idle and support grass or scattered trees and brush.

Erosion by wind and water is the principal limitation to cropping this soil. The available water capacity is moderate, and crops may not receive sufficient moisture during periods of limited precipitation. Improving and maintaining soil fertility are management concerns.

Erosion can be controlled by returning crop residue to the soil, seeding cover crops, and planting field shelterbelts. These practices also control snow blowing so more snow is held on fields, providing more moisture for plant growth. Adding barnyard manure provides some protective residue and increases fertility.

This soil is suited to most windbreak trees and shrubs that do not have a climatic limitation. Seedling mortality is slight to moderate, and plant competition is moderate.

Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIe.

335—Urness mucky silt loam. This very poorly drained, nearly level soil is in depressions and swales and on broad, low flats that are typically associated with the upland landscape. Individual areas of this soil are irregular in shape and typically range from 4 to 160 acres. This soil is subject to ponding.

Typically, this soil has a surface layer of very dark gray mucky silt loam about 10 inches thick. The underlying material to a depth of about 60 inches is calcareous, very dark gray and black mucky silt loam. In some areas, layers of fine sand are mixed with or underlie the mucky sediment. In some areas, organic layers of highly decomposed reeds and sedges are in the soil. Thin, darker colored mineral material is on the surface layer in a few areas.

Included with this soil in mapping, and making up less than 15 percent of most mapped areas, are small areas of Flom, Quam, and Rondeau soils. Flom soils do not have significant deposits of silty lake bottom sediment. Quam soils formed in less calcareous colluvial mineral material. Rondeau muck formed in organic material and marl. Flom, Quam, and Rondeau soils are on landscape positions similar to those of the Urness soils.

Permeability of this soil is moderate to moderately slow. Available water capacity is high to very high. Organic matter content is high. Surface runoff is ponded. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is less than 1 foot.

Most areas of this soil are idle or are included in areas used for hayland and pasture. A few areas of this soil are artificially drained and are included in cultivated fields. This soil is moderately suited to crop production. Small grain is the most common crop. Most idle areas support rushes, reeds, sedges, and lowland brush.

Wetness is the principal limitation to cropping this soil, and ponding is common. Wetness can be reduced by constructing ditches to remove excess water, but many depressions are so deeply pocketed that drainage of excess water is not economically feasible. A strongly calcareous soil condition also limits plant growth.

This soil is best suited to trees and shrubs that tolerate very wet, strongly calcareous soil. Seedling mortality and plant competition are severe, and limitations to the use of equipment are also severe.

This soil is generally not suited to use as building sites or to septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are generally nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding, frost action, and low soil strength.

This soil is in capability subclass IIIw.

343A—Wheatville silt loam, 0 to 2 percent slopes. This somewhat poorly and moderately well drained, nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 10 to 1,000 acres.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The next layer is very strongly calcareous, light brownish gray silt loam about 6 inches thick. This is underlain by a layer of faintly mottled, light yellowish brown very fine sandy loam about 8 inches thick. The contrasting underlying material to a depth of about 60 inches is mottled, olive gray and gray silty clay. In some areas, the contrasting underlying material is silty clay loam. In some areas, the surface layer is silty clay loam. In other areas, less than 24 inches of loamy and silty sediment is over the contrasting clayey underlying material. In a few areas, the surface layer is noncalcareous, but calcareous material is within 16 inches of the surface. A few areas have a thicker, dark colored surface layer and buried dark colored layers in the subsoil.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Augsburg and Glyndon soils. Augsburg soils are poorly drained and on slightly lower positions than the Wheatville soil. Glyndon soils are on similar landscapes and do not have contrasting silty clay within 40 inches of the surface.

Permeability of this soil is moderately rapid in the loamy upper part of the profile and slow in the clayey underlying material. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6 feet.

Nearly all of the acreage of this soil is cultivated, and this soil is well suited to cropland use. Small grain, sugar beets, sunflowers, and potatoes are the most common crops.

Soil blowing is the principal limitation to cropping this soil. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil and planting field shelterbelts help to control soil blowing. These practices help to hold and distribute snow cover, providing additional moisture for crops.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe.

If buildings are constructed on this soil, foundations and footings can be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

343B2—Wheatville loam, 2 to 6 percent slopes, eroded. This somewhat poorly and moderately well drained, gently sloping soil is on lake plains, typically near streams or drains leading into them. Individual areas of this soil are elongated in shape and typically range from 4 to 20 acres.

Typically, the surface layer is very dark gray and dark gray loam about 8 inches thick. The next layer is very strongly calcareous, light brownish gray silt loam about 6 inches thick. This is underlain by faintly mottled, pale brown very fine sandy loam about 10 inches thick. The contrasting underlying material to a depth of about 60 inches is mottled, olive gray and gray silty clay layered with silty clay loam and silt loam. In some areas, the surface layer is mixed with the underlying very strongly calcareous material. This mixing causes the surface to have colors of lighter gray, especially when the surface is dry. Some areas have less than 16 inches of loamy material over the contrasting clayey underlying material. A few areas have buried dark colored horizons. A few areas have slopes slightly greater than 6 percent.

Included with this soil in mapping, and making up 2 to 10 percent of most mapped areas, are small areas of Glyndon soils. Glyndon soils are on positions similar to those of the Wheatville soil and do not have contrasting silty clay within 40 inches of the surface.

Permeability of this soil is moderately rapid in the upper sediment and slow in the underlying material. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is medium. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

This soil is well suited to crop production, and nearly all of the acreage of this soil is cultivated. Small grain is the most common crop. Some areas of this soil are included in fields planted to sugar beets, potatoes, and sunflowers.

Water erosion is the principal limitation to cropping this soil. Soil blowing may occur in areas that are dry and have no vegetative cover. Improving or maintaining soil fertility is also a management concern.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour of slopes help to control soil erosion. Grassed waterways may be needed to prevent the formation of rills and gullies in areas of concentrated water flow.

This soil is best suited to windbreak trees and shrubs which tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicide help to remove competing plants.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

344—Quam clay loam. This very poorly drained, nearly level soil is in depressions and swales on upland landscapes. Individual areas of this soil are irregular in shape and typically range from 3 to 40 acres. This soil is subject to ponding.

Typically, the surface layer is black clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is also black clay loam. This layer has mottles below a depth of 41 inches. In places, the surface layer is calcareous. In a few areas, thin layers of highly decomposed organic material are on the surface. In a few areas, the soil has layers that contain more clay.

Included with this soil in mapping, and making up 2 to 12 percent of most mapped areas, are small areas of Flom and Urness soils. Flom soils do not have a significant thickness of colluvial material. Urness soils formed in silty lake bottom sediment. Flom and Urness soils generally are on landscape positions similar to those of the Quam soil.

Permeability of this soil is moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is ponded. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is less than 1 foot.

Most areas of this soil are idle or are included in areas used as pasture or hayland. Some of the low areas of this soil have been drained and filled and are included in cultivated fields. Small grain is the most common crop on these fields. Many areas of this soil are idle and generally support reeds, sedges, and some grasses.

Wetness is the principal limitation on this soil, and ponding is common. Constructing ditches to remove excess water reduces wetness. Some depressions are so deeply pocketed that draining excess water is not economically feasible.

This soil is best suited to trees and shrubs that tolerate very wet conditions. Seedling mortality and plant competition are severe on this soil, and limitations to the use of equipment are also severe.

This soil is generally not suited to use as building sites or as septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding, frost action, and low soil strength.

This soil is in capability subclass IIIw.

402B—Sioux sandy loam, 1 to 6 percent slopes. This excessively drained, nearly level and gently sloping soil is on the crest and upper slopes of ridges of beach deposits. Individual areas of this soil are irregular in shape and typically range from 10 to 200 acres.

Typically, the surface layer is black sandy loam about 9 inches thick. This grades to dark brown gravelly loamy coarse sand about 5 inches thick. The underlying material is brown gravelly loamy coarse sand grading with depth to light yellowish brown gravelly loamy coarse sand and extends to a depth of about 60 inches. In some areas, stones and boulders are scattered on the surface and buried in the upper part of the profile. In a few areas, loamy material is in the underlying material.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Lohnes coarse sandy loam and Maddock soils. Lohnes coarse sandy loam is well drained and contains less gravel in the underlying material than the Sioux soil. Maddock soils are well drained and do not have significant amounts of gravel and coarse sand. Maddock and Lohnes soils are on similar landscape positions.

Permeability is moderately rapid in the upper part of this Sioux soil and rapid in the underlying material. Available water capacity is low. Organic matter content is moderate. Surface runoff is slow to medium. Reaction in the surface layer is mildly alkaline.

Most areas of this soil are used as hayland and pasture. Other areas of this soil are idle and support introduced and native grasses and, in places, some trees or brush. Although this soil is not suited to cropping unless special management practices are used, a few areas are cultivated. Small grain, sunflowers, and corn are the most common crops. A significant acreage of this soil has been or is presently a source of sand and gravel for roadbuilding, road surfacing, and other construction uses.

A low available water capacity is the principal limitation to cropping this soil. Soil blowing is also a concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

In areas where this soil is cropped, returning crop residue to the soil and planting field shelterbelts hold snow cover and reduce the drying effect of wind. These practices allow the conservation and better use of available water and also help in controlling soil blowing. Adding barnyard manure provides some protective residue and increases fertility. If a water supply is available, irrigation may be considered to assure adequate moisture for plant growth. Production of hay and pasture crops can be improved by rotating pasture, delaying grazing, fertilizing, and controlling weeds.

The growth of windbreak trees is severely limited on this soil. Seedling mortality is severe on these soils. Onsite inspection helps to determine which species to plant and the proper management practices to follow.

This soil is well suited to use as sites for buildings and local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

This soil is in capability subclass VIs.

402C—Sioux sandy loam, 6 to 12 percent slopes. This excessively drained, sloping soil is on the crest and upper slopes of ridges on lake plains. Individual areas of this soil are irregular in shape and typically range from 5 to 80 acres.

Typically, the surface layer is black sandy loam about 8 inches thick. This grades to dark brown gravelly coarse sand about 5 inches thick. The underlying material to a depth of about 60 inches is brown gravelly loamy coarse sand grading with depth to light yellowish brown gravelly loamy coarse sand. In some areas, stones and boulders are scattered on the surface and buried in the upper part of the profile. A few areas have loamy material in the underlying material. A few small areas have slopes slightly greater than 12 percent.

Included with this soil in mapping and making up 5 to 15 percent of most mapped areas are small areas of Lohnes coarse sandy loam and Maddock soils. Lohnes coarse sandy loam is on positions similar to those of the Sioux soil, is well drained, and contains less gravel in the underlying material. Maddock soils are well drained and do not have significant amounts of gravel and coarse sand. They are on convex, irregularly shaped areas.

Permeability is moderately rapid in the upper part of this Sioux soil and rapid in the underlying material. Available water capacity is low. Organic matter content is moderate. Surface runoff is medium. Reaction in the surface layer is mildly alkaline.

Most areas of this soil are used as hayland and pasture. Other areas of this soil are idle and support introduced and native grasses and, in places, some trees and brush. This soil is not suited to cropping unless special management practices are used. A few areas of this soil are cultivated. Small grain, sunflowers, and corn are the most common crops. Some of this soil has been or is presently a source of sand and gravel for roadbuilding, road surfacing, and other construction uses.

A low available water capacity is the principal limitation to cropping this soil. Erosion by wind and water is also a concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Practices such as returning crop residue to the soil and planting field shelterbelts control snow blowing and reduce the drying effect of wind, thereby allowing the conservation and better use of available water. These practices also help to control soil erosion. Adding barnyard manure provides some protective residue and increases fertility. If a water supply is available, irrigation may be considered to assure adequate moisture for plant growth. Productivity of hay and pasture crops can be increased by rotating pasture, delaying grazing, fertilizing, and controlling weeds.

The growth of windbreak trees is severely limited on this soil. Seedling mortality is severe on this soil. Onsite inspection may help to determine which species to plant and the proper management practices to follow.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

This soil is in capability subclass VIIs.

402D—Sioux loamy coarse sand, 12 to 18 percent slopes. This excessively drained, hilly soil is on upland landscapes. Individual areas of this soil are irregular in shape and typically range from 5 to 160 acres.

Typically, the surface layer is very dark brown loamy coarse sand about 7 inches thick. Below the surface layer is dark brown gravelly loamy sand about 5 inches thick. This is underlain by pale brown gravelly loamy coarse sand that extends to a depth of about 60 inches. In some areas, stones and boulders are on the surface and in the upper part of the profile. In some small areas, loamy material overlies the gravelly and sandy underlying material. In a few small areas, the surface layer is very thin and the underlying material has been mixed with it. A few areas have slopes greater than 18 percent.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Lohnes and Maddock soils. Lohnes soils are on similar positions and contain less gravel below the surface layer than the Sioux soil. Maddock soils are well drained, do not have significant amounts of gravel and coarse sand, and are on slightly lower positions.

Permeability is moderately rapid in the upper part of this Sioux soil and rapid in the lower part. Available water capacity is very low. Organic matter content is moderate to low. Surface runoff is medium. Reaction in the surface layer is neutral or mildly alkaline.

This soil typically supports introduced and native grasses. It is not suited to cultivation. Some areas are in woodland, and oak is the most common tree. Some areas of this soil are used for limited grazing or are idle. A few small areas are excavated for sand and gravel.

Slope is the main limitation to use of this soil as building sites. Extensive land shaping is generally needed. Buildings and lots can be designed to conform to the natural slope of the land. Extensive cutting and filling is generally needed if roads are constructed on this soil. Roads should be placed on the contour and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

This soil is poorly suited to septic tank absorption fields because of the steepness of slope and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field and placing distribution lines across the slope help to lessen the severity of the slope limitation and the pollution hazard.

This soil is in capability subclass VIIs.

402E—Sioux bouldery loamy coarse sand, 12 to 30 percent slopes. This excessively drained, hilly to very steep soil is on upland landscapes. Individual areas of this soil are irregular in shape and typically range from 10 to 120 acres.

Typically, the surface layer is very dark brown bouldery loamy coarse sand about 3 inches thick. Below the surface layer is dark brown gravelly loamy sand about 12 inches thick. The underlying material to a depth of about 60 inches is pale brown gravelly coarse sand. In some areas, boulders are in the underlying material. In some areas, the slope is as great as 40 percent.

Included with this soil in mapping, and making up 10 to 15 percent of most mapped areas, are small areas of Langhei, Lohnes, and Waukon soils. Langhei soils are on positions similar to those of the Sioux soil, are finer textured, and are more strongly calcareous at and near the surface. Lohnes soils have gravel below the surface soil. They typically are less steep. Waukon soils typically are on similar positions, are finer textured throughout, and do not have sandy or gravelly layers over 6 inches thick.

Permeability is moderately rapid in the subsoil of this Sioux soil and rapid in the underlying material. Available water capacity is very low. Organic matter content is moderate to low. Surface runoff is medium or rapid. Reaction in the surface layer is neutral or mildly alkaline.

Most areas of this soil typically support introduced and native grasses. Some areas are in woodland, and oak is the most common tree. Areas of this soil are used for limited grazing or are idle. Some small areas are excavated for sand and gravel. This soil is not suited to cultivation.

Slope is the main limitation to use of this soil as building sites. Extensive land shaping is generally needed. Buildings and lots should be designed to conform to the natural slope of the land. Extensive cutting and filling is generally needed if roads are constructed on this soil. Roads should be placed on the contour and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

This soil is poorly suited to septic tank absorption fields because of the steepness of slope and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field and placing distribution lines across the slope help to lessen the severity of the slope limitation and the pollution hazard.

This soil is in capability subclass VIIs.

403—Viking sandy clay loam. This poorly drained, nearly level soil is on plane or slightly concave positions on lake plains. Areas of this soil are irregular in shape and typically range from 4 to 200 acres.

Typically, the surface layer is black sandy clay loam about 12 inches thick. The subsoil is dark grayish brown clay about 9 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown, dark grayish brown, and olive gray, strongly calcareous clay. In some areas, the underlying material is not mottled, and in some small areas, it contains less clay. In a few areas, the soil is calcareous within 16 inches of the surface.

Included with this Viking soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Donaldson, Fargo, and Northcote soils. The Donaldson soils commonly are on slightly higher positions than the Viking soil, are somewhat poorly drained and moderately well drained, and formed in thicker loamy sediment over clay. Fargo soils are on similar positions, do not have coarse fragments, and contain less clay in the underlying material. Northcote soils also are on similar positions and do not have significant coarse fragments in the surface layer.

Permeability of this soil is very slow. Available water capacity is moderate. Organic matter content is high. Surface runoff is slow. Reaction of the surface layer is mildly alkaline. Depth to the seasonal high water table is 1 foot to 3 feet.

In most areas the Viking soil is cultivated and is well suited to cropland use. Small grain, sunflowers, and sugar beets are the most common crops. A few areas are used for pasture and hayland.

Wetness is the principal limitation to cropping this soil. Coarse fragments on the surface may interfere with the operation of farm machines. Soil blowing may occur on cultivated fields that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Practices such as returning crop residue to the soil, stubble mulching, and seeding cover crops reduce soil blowing and improve soil tilth. Fertility can be improved by applications of fertilizer based on the results of soil tests. On some areas, stones should be removed so that farm machines can be operated efficiently.

This soil is best suited to windbreak trees and shrubs that tolerate wetness and high clay content in the soil. Seedling mortality in this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of this soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by low soil strength and shrinking and swelling of the soil.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

413—Osakis loam. This moderately well drained, nearly level soil is on upland landscapes. Individual areas of this soil vary in shape and typically range from 5 to 40 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is dark brown sandy loam about 9 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown gravelly loamy sand grading with depth to light brownish gray gravelly coarse sand. In some areas, the surface layer and dark colored subsoil are less than 16 inches thick. In a few areas, the soil is calcareous throughout. Some areas have a surface layer of loamy fine sand greater than 15 inches thick.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Kittson, Lohnes, and Sverdrup soils. Kittson soils are on positions similar to those of the Osakis soil, are somewhat poorly drained and moderately well drained, and have loamy underlying material. Lohnes soils are coarser textured in the upper part. Some are on similar positions and are moderately well drained, and some are on higher positions and are well drained. Sverdrup soils are somewhat excessively drained and commonly are on higher positions.

Permeability of this soil is moderate or moderately rapid in the upper part and rapid in the lower part. Available water capacity is low. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is slightly acid. Depth to the seasonal high water table is 4 to 6 feet.

Many areas of this soil are cultivated. This soil is moderately suited to crop production. Small grain, sunflowers, and corn are the most common crops. Other areas are used for hayland and pasture. A few areas are idle and support grasses and, in a few places, scattered trees.

Low available water capacity and the possibility of soil blowing are the principal limitations to the use of this soil as cropland. Fall seeding crops such as rye and winter wheat allows the conservation and better use of available water. Practices such as stubble mulching and planting field windbreaks control soil blowing and hold snow cover, adding to the moisture supply. If water is available, irrigation can be used to increase crop production. Inherent fertility of this soil is medium to low, and adding commercial fertilizers is needed to assure adequate fertility for crops.

This soil is best suited to windbreak trees and shrubs that tolerate some drought. In some seasons, droughty conditions may result in moderate to severe seedling mortality. Plant competition is moderate.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

This soil is in capability subclass IIIs.

425—Donaldson fine sandy loam. This somewhat poorly drained and moderately well drained, nearly level soil is on lake plains. It is typically on slightly convex areas and on low ridges. Individual areas of this soil are irregular in shape and typically range from 10 to 400 acres.

Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 11 inches thick. This layer grades from very dark grayish brown to dark brown. The next layers are mottled, brown fine sandy loam about 6 inches thick grading to slightly calcareous, mottled, light brownish gray very fine sandy loam about 6 inches thick. The contrasting underlying material to a depth of about 60 inches is strongly calcareous, dark gray clay. In some areas the soil has gravel and cobblestones just above the clay material.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Wheatville, Foldahl, and Overly soils. Wheatville soils have a concentration of carbonates within 16 inches of the surface. Foldahl soils are moderately well drained and formed in sandier upper sediment. Overly soils are moderately well drained and formed in finer textured material. Foldahl, Overly, and Wheatville soils commonly are on positions similar to those of the Donaldson soil.

Permeability of this soil is moderately rapid in the loamy upper part of the profile and slow in the clayey underlying material. Available water capacity is moderate. Organic matter content is moderate to high. Surface runoff is moderate to slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain, sunflowers, potatoes, and sugar beets are the most common crops. A few areas of this soil are used for forage production, and corn, alfalfa, and grasses are the most common crops.

Soil blowing is the principal hazard to cropping this soil. Improving and maintaining soil fertility are management concerns. Seeding cover crops, stubble mulching, and planting field windbreaks help to control soil blowing.

This soil is suited to most windbreak trees and shrubs that have no climatic limitation. Seedling mortality is commonly moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIc.

426—Foldahl loamy fine sand. This moderately well drained, nearly level soil is on slightly convex areas that typically are part of lake-modified till plains or lake plains Individual areas of this soil are irregular in shape and typically range from 5 to 50 acres.

Typically, the surface layer is black loamy fine sand about 11 inches thick. The upper part of the subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The lower part is mottled, dark brown fine sand about 6 inches thick. Underlying this is about 7 inches of mottled, brown loamy fine sand. The contrasting underlying material to a depth of about 60 inches is mottled, mixed light brownish gray and light gray loam. Some areas have a dark colored surface layer that is more than 16 inches thick. In a few areas, stones and boulders are on the surface and buried in the upper part of the profile. In some areas the surface layer is calcareous. In a few areas, gravelly layers are in the upper part of the soil. In some areas, the surface layer is sandy loam and the subsoil is underlain by sand that extends to more than 40 inches.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Grimstad, Flaming, and Swenoda soils. These soils are commonly on landscapes similar to those of the Foldahl soil. Grimstad soils are somewhat poorly drained and moderately well drained, have a finer textured surface layer, and are strongly calcareous at and near the surface. Flaming soils are somewhat poorly drained and moderately well drained and do not have finer textured material within 40 inches of the surface. Swenoda soils developed in finer textured upper sediment.

Permeability of this soil is rapid in the sandy upper part of the profile and moderately slow or moderate in the contrasting loamy underlying material. Available water capacity is moderate to low. Organic matter content is moderate to high. Surface runoff is slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Some areas of this soil are cultivated, and small grain is the most common crop. This soil is moderately suited to crop production. Some corn and rotation hay and pasture are commonly a part of these farming operations. Other areas are used for permanent hayland and pasture. A few areas are idle and support mixed grasses and some scattered trees.

Moderate to low available water capacity, moderate to low inherent fertility, and a hazard of soil blowing are limitations to cropping this soil. Stubble mulching and planting field windbreaks help to control soil blowing. In addition, these practices hold snow cover on fields, increasing the available water supply. Fall-sown crops such as rye and winter wheat also provide cover and are commonly grown when more water is available in these soils. Productivity of hay and pasture crops can be improved by rotating pasture, delaying grazing, fertilizing, and controlling weeds.

This soil is best suited to windbreak trees and shrubs that tolerate some drought. In some seasons, droughty conditions may result in moderate to severe seedling mortality. Plant competition is moderate.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of this soil with changes in its moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to septic tank absorption fields because the upper part of the soil does not adequately filter the effluent and the lower part does not readily absorb effluent. The seasonal high water table is an additional limitation to the use of this soil as septic tank absorption fields. The poor filtering capacity of the soil may result in the pollution of ground water. Installing a larger than average drain field helps to lessen the severity of these limitations.

This soil is in capability subclass IIIs.

429—Northcote clay. This poorly drained, nearly level soil is on lake plains. Areas of this soil are irregular in shape and typically range from 60 to 1,500 acres. This soil is subject to rare flooding.

Typically, the surface layer, which is about 18 inches thick, is black clay grading to very dark gray clay. The subsoil is dark gray clay about 17 inches thick. The underlying material to a depth of about 60 inches is mottled, dark gray and gray clay. In some areas, the surface layer is silty clay.

Included with this soil in mapping, and making up from 5 to 15 percent of most mapped areas, are areas of Fargo and Viking soils. Fargo soils are on landscapes similar to those of the Northcote soil and contain less clay. Viking soils are on similar landscapes and have more coarse fragments in the surface layer.

Permeability of this soil is slow. Available water capacity is moderate. Organic matter content is high. Surface runoff is very slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 1 foot to 3 feet.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Small grain, principally wheat and barley, and sugar beets are the most common crops. Some areas of this soil are planted to sunflowers and soybeans.

Wetness and a high clay content are the principal limitations to cropping this soil. Constructing open field ditches helps to remove excess water. Timely tillage is important on the Northcote soil, as cultivating this soil when it is wet compacts the soil, damages its structure, and makes seedbed preparation difficult. Practices such as returning crop residue and plowing under green manure crops maintain organic matter content and maintain or improve soil tilth. Application of commercial fertilizer based on the results of soil tests is necessary to assure productivity because the high clay content of this soil tends to reduce the availability of some nutrients, especially phosphorus.

This soil is best suited to windbreak trees and shrubs that tolerate a soil that is wet and has a high clay content. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the seasonal high water table, the shrinking and swelling of the soil with changes in moisture content, and the flood hazard. If buildings are constructed on this soil, the lower level should be above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Backfilling around foundations with suitable coarse material helps protect the foundation from damage caused by shrinking and swelling of the soil. Landscaping should be designed to drain surface water away from buildings.

Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

435—Syrene sandy clay loam. This poorly drained, nearly level soil is in shallow swales on lake plains and in some outwash areas. Individual areas of this soil are irregular in shape and typically range from 5 to 50 acres.

Typically, the surface layer is very dark gray sandy clay loam about 9 inches thick. Below that, to a depth of 27 inches, the material is very strongly calcareous. It is dark gray sandy clay loam in the upper 8 inches and light brownish gray gravelly fine sand in the lower 10 inches. The underlying material to a depth of about 60 inches is strongly calcareous, light olive gray gravelly fine sand. In some areas, loamy material is within 40 inches of the surface.

Included with this soil in mapping, and making up less than 15 percent of most mapped areas, are small areas of Rockwell and Markey soils. Rockwell soils are on landscape positions similar to those of the Syrene soils and have contrasting loamy material within 40 inches of the surface. Markey mucks are on lower positions, are very poorly drained, and formed in organic soil material over sand.

Permeability of this soil is moderately rapid in the upper part and rapid in the underlying material. Available water capacity is low. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 1 foot to 3 feet.

Most areas of this soil are in grass and are used for hay and pasture. A few areas of this soil are cultivated. Small grain, sunflowers, and corn are the most common crops. Some areas of this soil are idle and support grasses, sedges, and lowland brush. Scattered trees are also on some of these areas.

Wetness is the principal limitation to cropping this soil. Soil blowing may occur in areas where the surface has no vegetative cover. Improving and maintaining soil fertility are management concerns. Because of low available water capacity in the underlying material, this soil may be droughty during dry seasons.

Constructing open field ditches reduces wetness. The gradient of these ditches is critical, as flowing water erodes soil materials easily. Establishing grass in the ditches reduces the formation of rills and gullies by flowing water. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing. Productivity of hay and pasture crops can be improved by rotating pasture, delaying grazing, fertilizing, controlling weeds, and installing drains.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality on this soil is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without basements and landscaping should be designed to drain surface water away from the buildings. Constructing tile drains around foundations helps to remove excess subsurface water. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help overcome wetness and protect the roads from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IVw.

494—Darnen loam. This moderately well drained, nearly level to gently sloping soil is on upland landscapes. Areas commonly are elongated and have slightly irregular lines that follow the base of slopes. Individual areas of this soil typically range from 3 to 20 acres.

Typically, the surface layer is black loam about 18 inches thick. The next layer is brown loam about 7 inches thick. The subsoil is very dark grayish brown loam about 23 inches thick. The underlying material to a depth of about 60 inches is mottled, dark grayish brown loam. Some places have sand and gravel layers less than 6 inches thick just above the underlying loamy material. In some areas, the surface layer is calcareous. A few places have underlying material of silt loam.

Included with this soil in mapping, and making up 2 to 10 percent of most mapped areas, are small areas of Flom, Gonvick, and Kittson soils. Flom soils are poorly drained and have a thinner dark surface layer. They commonly are in lower lying swales and shallow depressions. Gonvick soils have a thinner dark surface layer and more clay in the subsoil. They are typically on slightly more convex areas, commonly not at the base of slopes. Kittson soils are somewhat poorly drained and moderately well drained and have a thinner dark surface layer. They are in similar positions or are in slightly lower positions than the Darnen soil.

Permeability of this soil is moderate. Available water capacity is moderate. Organic matter content is high. Surface runoff is medium to slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas of this soil are used for hayland and pasture. A few areas are in woodland or are idle.

Erosion by wind or water may occur on cultivated areas that have no vegetative cover. Water runoff from adjacent slopes may delay farming during early spring and periods of heavy rainfall. Improving and maintaining soil fertility are management concerns. Seeding cover crops and stubble mulching are the practices most commonly used to reduce erosion.

This soil is suited to most windbreak trees and shrubs that have no climatic limitation. Seedling mortality is commonly moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Buildings constructed without basements should be built on coarse textured fill material to prevent damage caused by low soil strength. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIc.

506—Overly silty clay loam. This moderately well drained, nearly level soil is on lake plains. A few areas are on slightly concave positions. Individual areas of this soil are irregular in shape and typically range from 10 to 200 acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is very dark grayish brown silty clay loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown and grayish brown silty clay loam. This material is mottled below 28 inches. Some areas have less than 16 inches of dark colored soil material. Some areas have bands of sandy material more than 6 inches thick at a depth of more than 40 inches.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Bearden, Donaldson, and Wahpeton soils. Bearden soils are somewhat poorly drained and moderately well drained and are strongly calcareous at or near the surface. Donaldson soils are somewhat poorly drained and moderately well drained and have coarser textured material in the upper part of the profile and clay underlying material. Wahpeton soils are somewhat poorly drained and moderately well drained and are fine textured throughout. Bearden, Donaldson, and Wahpeton soils typically are on landscape positions similar to those of the Overly soil.

Permeability of this soil is moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is neutral.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Wheat, barley, sugar beets, sunflowers, and potatoes are the most common crops.

Soil blowing occurs in areas where this soil is cultivated and has no protective cover. Returning crop residue to the soil and seeding cover crops help to control soil blowing.

This soil is suited to most windbreak trees and shrubs that have no climatic or disease limitation. Seedling mortality is commonly low to moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by low strength and frost action.

The moderately slow permeability of this soil prevents it from readily absorbing effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

This soil is in capability subclass IIc.

508—Wyndmere fine sandy loam. This somewhat poorly drained, nearly level soil is on lake plains. It is on level or slightly convex areas and, in places, on low ridges. Individual areas of this soil are irregular in shape and typically range from 20 to 500 acres.

Typically, the surface layer is black fine sandy loam about 10 inches thick. Below this is a very dark grayish brown fine sandy loam layer that has a concentration of carbonates and is about 5 inches thick. The material below that, to a depth of about 29 inches, is very strongly calcareous. It is dark grayish brown loamy fine sand in the upper 6 inches and grayish brown fine sandy loam in the lower 8 inches. The underlying material to a depth of about 60 inches is mottled, pale yellow grading to light brownish gray fine sand and very fine sand. Some areas have buried dark colored layers and a thicker surface layer. A few areas have thin gravel layers in the underlying material. Some small areas have more sand in the profile.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Borup and Elmville soils. Borup soils are poorly drained and are on slightly lower pockets and swales than the Wyndmere soils. Elmville soils are on similar landscapes, are somewhat poorly drained and moderately well drained, and have contrasting clayey material within 40 inches of the surface.

Permeability of this soil is moderately rapid. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 5.0 feet.

Most areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, potatoes, sugar beets, and sunflowers are the most common crops. Some areas of this soil are used for forage production. Corn, alfalfa, and grasses are the most common crops.

Soil blowing and a strongly calcareous condition that places some stress on plant growth are the principal limitations to cropping this soil. Seeding cover crops, stubble mulching, minimum tillage, and planting field windbreaks help to control soil blowing. Improving drainage on associated wet areas and applying phosphorus and potassium help to overcome nutrient imbalances caused by the strongly calcareous soil condition.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIe.

509—Vallers bouldery loam. This poorly drained, nearly level soil is on upland and lake-washed till landscapes. Individual areas of this soil are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is strongly calcareous black bouldery loam about 10 inches thick. The next layer is very strongly calcareous, mottled, gray clay loam about 16 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, mottled, olive gray loam. In some places, sand and gravel layers are in the underlying material. Some areas have a dark colored surface layer that is more than 24 inches thick. A few places have a sandy loam surface layer. Some areas have only a few surface stones and boulders.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Flom and Hamerly soils. Flom soils are on positions similar to those of the Vallers soil and are noncalcareous in the surface soil and subsoil. Hamerly soils are somewhat poorly drained and moderately well drained and typically are on slightly higher, more convex positions.

Permeability of this soil is moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 1 foot to 2.5 feet.

Nearly all of the acreage of this soil is idle or is in pasture. These areas support wetland grasses, sedges, and lowland brush. This soil is not suited to crop production.

Boulders and stones are the main limitation to cultivating this soil. Operation of most farm machines is not possible unless the boulders and stones are removed from the soil. Wetness is also a limitation to crop production. Constructing open field ditches reduces wetness. Productivity of pasture can be improved by rotating pasture, delaying grazing, fertilizing, controlling weeds, and installing drains.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality is moderate, and plant competition and equipment limitations are severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower or basement level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to overcome the wetness limitation.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass VIs.

510—Elmville fine sandy loam. This somewhat poorly drained and moderately well drained, nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 15 to 500 acres.

Typically, the surface layer is black fine sandy loam about 11 inches thick. A layer of very dark gray very fine sandy loam that has a concentration of carbonates lies beneath the surface layer. This layer is about 3 inches thick. The next layers are very strongly calcareous, dark grayish brown and grayish brown very fine sandy loam about 16 inches thick. The underlying material is mottled, light yellowish brown loamy fine sand in the upper 4 inches. Below that to a depth of about 60 inches the contrasting underlying material is mottled, very dark gray and dark olive gray clay. Some areas have less than 30 inches of loamy sediment over clay. Some areas have been moderately eroded. A few areas have layers of sand in the underlying material. Some areas have buried dark colored layers.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Augsburg and Wyndmere soils. Augsburg soils are poorly drained and are in lower lying pockets and swales. Wyndmere soils are on similar landscapes, are somewhat poorly drained, and do not have contrasting clayey underlying material.

Permeability of this soil is moderately rapid in the upper part of the profile and slow in the clayey underlying material. Available water capacity is moderate. Organic matter content is moderate to high. Surface runoff is slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 2 to 5 feet.

Most areas of this soil are cultivated. This soil is well suited to cropland use. Small grain, sunflowers, potatoes, and sugar beets are the most common crops. A few areas of this soil are used for forage production, and corn, alfalfa, and grasses are the most common crops.

Soil blowing and a strongly calcareous soil condition that places some stress on plant growth are the principal limitations to cropping this soil. Seeding cover crops, stubble mulching, and planting field windbreaks help to control soil blowing. Improving drainage on associated wet areas and applying commercial fertilizers based on soil tests improve nutrient levels and reduce the effects of the strongly calcareous condition.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinkage and swelling of this soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIe.

540—Seelyeville muck. This very poorly drained, nearly level soil is on concave slopes and in closed depressions on uplands and lake-washed till plains. Areas are irregular in shape, but many areas are nearly circular or elongated, parallel to slopes or higher areas. Individual areas of this soil typically range from 5 to 200 acres. This soil is subject to ponding.

Typically, the surface layer is very dark brown and grades to dark brown and very dark grayish brown, highly decomposed organic material about 60 inches thick. Some areas have free carbonates in the organic soil material. Some areas have loamy to sandy mineral soil material within 51 inches of the surface.

Permeability of this soil is moderately rapid to moderately slow. Available water capacity is high. Organic matter content is very high. Surface runoff is very slow or ponded. Reaction in the surface layer is neutral. Depth to the seasonal high water table is less than 2 feet.

Most areas of this soil are idle. They provide habitat for wildlife. A few acres are in pasture or hayland, and, occasionally, some areas of this soil are cultivated along the edges. This soil is poorly suited to crop production.

Wetness is the principal limitation to cropping this soil. The low natural fertility of the soil and the possibility of frost damage are also limitations. Most areas are difficult to drain, and these areas are best suited to use as wildlife habitat.

This soil is suited to some windbreak trees that tolerate very wet soil. Seedling mortality for most trees and shrubs is severe. Plant competition and equipment limitations are severe.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass IVw.

543—Markey muck. This very poorly drained, nearly level soil is on concave slopes or in closed depressions on uplands and lake-modified till plains. Areas of this soil are nearly circular or elongated and typically range from 4 to 120 acres. This soil is subject to ponding.

Typically, the surface layer is very dark gray, highly decomposed organic material about 28 inches thick. The contrasting underlying material to a depth of about 60 inches is gray sand. In places, the organic material is less than 16 inches thick. In some places, shell fragments are on the surface and the soil is strongly calcareous. A few areas have layers of organic material that are not highly decomposed.

Included with this soil in mapping, and making up 2 to 10 percent of most mapped areas, are areas of Arveson and Rockwell soils. Arveson soils do not have organic upper material and are more strongly calcareous. The Rockwell soil formed in sandy material and underlying medium textured material. Areas of Arveson and Rockwell soils included in this map unit typically are on landscapes similar to those of the Markey soil.

Markey muck has moderately slow permeability in the upper organic material and rapid permeability in the underlying sand. Available water capacity is high. Organic matter content is very high. Surface runoff is ponded or very slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is less than 1 foot.

Most areas of this soil are idle. They provide cover and habitat for wildlife. A few acres are included in pasture, and some areas of this soil are cultivated along the edges. This soil is poorly suited to crop production.

Wetness is the principal limitation to cropping this soil. Low natural fertility and the possibility of frost damage are additional limitations. Most areas are difficult to drain and are best suited to development for wildlife habitat.

This soil is suited to some windbreak trees that tolerate very wet soil. For most trees and shrubs, seedling mortality is severe. Plant competition and equipment limitations are also severe.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost

This soil is in capability subclass IVw.

544—Cathro muck. This very poorly drained, nearly level soil is on concave slopes or in closed depressions on uplands and lake-washed till plains. Individual areas typically are circular or are elongated and parallel to slopes or higher areas. Individual areas of this soil typically range from 4 to 100 acres. This soil is subject to ponding.

Typically, the surface material is black muck about 21 inches thick. The underlying material is very strongly calcareous, dark gray silty clay loam in the upper 19 inches and grades to gray clay loam, which extends to a depth of about 60 inches. Some areas have less than 16 inches of organic surface material. In some places, the soil is calcareous throughout. Stones and boulders are on some areas.

Included with this soil in mapping, and making up 2 to 10 percent of most mapped areas, are small areas of Flom soils. Flom soils are on similar landscapes and formed in mineral soil material.

Permeability of this soil is moderately rapid to moderately slow. Available water capacity is very high. Organic matter content is very high. Surface runoff is very slow or ponded. Reaction in the surface layer is neutral. Depth to the seasonal high water table is less than 1 foot.

Some areas of this soil are used for hay and pasture. Many areas are idle and provide cover and habitat for wildlife. This soil is poorly suited to crop production; however, a few areas have been drained and are cultivated. These areas are commonly included in fields planted to small grain.

Wetness is the principal limitation to cropping this soil. Low natural fertility is a limitation and the frost damage is a hazard. Most areas of this soil are difficult to drain and are best suited to use as wildlife habitat.

This soil is suited to some windbreak trees that tolerate very wet soil. Seedling mortality for most trees and shrubs is severe. Plant competition and equipment limitations are also severe.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass IVw.

545—Rondeau muck. This very poorly drained, nearly level soil is in depressions on uplands and lake-washed till plains. Individual areas of this soil are irregular in shape and typically range from 10 to 1,500 acres. This soil is subject to ponding.

Typically, the surface material is highly decomposed organic material that grades in color from very dark grayish brown to very dark gray, dark grayish brown, and black. This material is about 50 inches thick. The underlying material to a depth of about 130 inches is very strongly calcareous, very dark gray, and light gray mucky mineral material and marl. In some areas, organic material extends to a depth greater than 50 inches.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Urness soils. Urness soils typically are on landscapes similar to those of the Rondeau soil and formed in coprogenous earth and underlying loamy sediment.

Permeability of this soil is moderately slow and slow. Available water capacity is high. Organic matter content is very high. Surface runoff is very slow or ponded. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is less than 1 foot.

Most areas of this soil are idle, and these areas provide cover and habitat for wildlife. A few acres are in pasture, and some areas of this soil are cultivated along the edges. This soil is not suited to crop production except for specialty crops or where a major reclamation project alters capability.

Wetness is the principal limitation to cropping this soil. Low natural fertility is a limitation, and the frost damage is a hazard. Most areas are difficult to drain and are best suited to use as wildlife habitat.

This soil is suited to some windbreak trees that tolerate very wet soil. Seedling mortality is severe for most trees and shrubs. Plant competition and equipment limitations are also severe.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass Vw.

609—Dickey loamy fine sand. This well drained, nearly level soil is on lake plains. Individual areas are irregular in shape and typically range from 4 to about 30 acres.

Typically, the surface layer is loamy fine sand about 13 inches thick. It ranges in color from black to very dark gray. The subsoil is dark grayish brown loamy sand about 11 inches thick. The underlying material to a depth of about 60 inches is calcareous, mottled, light brownish gray silty clay loam. Some places have a thin surface layer of fine sandy loam. In some areas, a thin stone or gravel layer is in the upper part of the subsoil.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Foldahl, Lohnes, and Swenoda soils. Foldahl soils are moderately well drained and typically are on slightly lower positions on the landscape than the Dickey soil. Lohnes soils are on slightly lower landscape positions and do not have loamy contrasting material. Maddock soils are on similar landscape positions and do not have contrasting loamy material within 40 inches of the surface.

Permeability of this soil is rapid in the upper sediment and moderately slow in the contrasting underlying material. Available water capacity is low. Organic matter content is moderate. Surface runoff is slow to medium. Reaction in the surface layer is slightly acid. Depth to the seasonal high water table is greater than 6 feet.

Most areas of this soil are cultivated, but this soil is poorly suited to crop production. Small grain, sunflowers, and corn are the most common crops. Some areas are used for hayland and pasture. A few areas are idle and support grass or trees.

Soil blowing is the principal hazard to cropping this soil. Improving and maintaining soil fertility are management concerns. This soil tends to be droughty during dry seasons. Seeding cover crops, stubble mulching, planting field shelterbelts, and cultivating on the contour help to control soil blowing. If suitable water is available, irrigation assures adequate moisture for plant growth.

This soil is best suited to windbreak trees and shrubs that tolerate some drought. In some seasons, droughty conditions may result in moderate to severe seedling mortality.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. This soil is well suited to road construction.

This soil is poorly suited to use as septic tank absorption fields because the upper part of the soil does not adequately filter the effluent and the lower part does not readily absorb effluent. The poor filtering capacity of the soil may result in the pollution of ground water. Installing a larger than average drain field helps to lessen the severity of these limitations.

This soil is in capability subclass IVe.

841—Urban land-Fargo complex. This nearly level map unit is mostly on lake plains that have alluvial fans. About 80 percent is Urban land, and 20 percent is poorly drained Fargo soils. The areas of Urban land and Fargo soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping.

The Urban land part of this map unit is mostly covered by residential developments. Other areas are used for shopping centers, theaters, auto dealerships, supermarkets, and other businesses and adjacent parking lots. Identification of soil material is not feasible.

Typically, undisturbed areas of Fargo soils have a surface layer of black silty clay about 12 inches thick. The subsoil is very dark gray silty clay about 12 inches thick. The next layer is strongly calcareous, olive gray silty clay about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, olive gray clay and silty clay loam. In some places, construction and excavation have mixed or altered the soil. On these areas, the underlying material may be exposed or the soil may be covered by fill of varying depths.

Included with this map unit are small areas of Bearden, Colvin, Overly, and Wahpeton soils. Bearden soils are somewhat poorly drained and moderately well drained and formed in silty clay loam and silt loam material. Bearden and Colvin soils are strongly calcareous at or near the surface. Bearden soils are on higher landcape positions than the Fargo soils and the Urban land, and Colvin soils are typically on similar positions. Overly soils are on higher landscape positions and are moderately well drained. Wahpeton soils are somewhat poorly drained and moderately well drained and are commonly on higher terracelike positions near the Red River. Also included are areas that have slopes ranging from 2 percent to more than 18 percent and commonly are parallel to well entrenched stream channels. Areas below these slopes are frequently flooded.

Permeability of Fargo soils in this map unit is slow. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is less than 3 feet.

The soils in this map unit are best suited to trees and shrubs that tolerate wet and clayey soil. They are generally well suited to lawn grasses, but preparing a seedbed for the grasses is difficult.

Buildings constructed on these soils should have the lower level constructed above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping can be designed to drain surface water away from buildings. Foundations and footings can be designed to prevent structural damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against damage to structures. Roads can be constructed on raised, coarse textured fill material, and adequate side ditches and culverts can be provided to minimize wetness and to help protect the roads from damage caused by low soil strength.

The soils in this complex are poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the permeability of these soils restricts them from readily accepting effluent. In some places, a mound type of absorption field may be suitable.

This soil is not assigned to a capability subclass.

892B—Sioux-Sverdrup complex, 1 to 6 percent slopes. These nearly level and gently undulating soils are on uplands. The Sioux soils are excessively drained, and the Sverdrup soils are somewhat excessively drained. These soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 50 percent of this map unit is Sioux soils, and 35 percent is Sverdrup soils. The Sioux soils are typically on knobs and the upper part of side slopes. The Sverdrup soils are on the lower part of side slopes. Individual areas are irregular in shape and typically range from 5 to 50 acres.

Typically, the Sioux soils have a surface layer of very dark brown gravelly loamy sand about 9 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown gravelly coarse sand. In some areas, the surface layer is gravelly loamy sand that is grayish brown and light brownish gray when dry.

Typically, the Sverdrup soils have a surface layer of black sandy loam about 10 inches thick. The subsoil is brown sandy loam about 4 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand. In some areas, the surface layer is black and very dark brown sandy loam more than 16 inches thick.

Included in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Darnen, Lohnes, and Maddock soils. Darnen soils are moderately well drained, have a thick, dark colored surface soil, and are on the base of slopes. Lohnes soils are moderately well drained and well drained. They are on positions similar to those of the Sioux and Sverdrup soils. Maddock soils are on positions similar to those of the Sioux and Sverdrup soils, are well drained, and have little or no gravel in the underlying material.

Permeability of the Sioux soils is moderately rapid or rapid throughout the profile. The Sverdrup soils have moderately rapid permeability in the upper sediment and rapid permeability in the underlying material. Available water capacity in these soils is low, and the organic matter content is moderate. Surface runoff is slow. Reaction in the surface layer is mildly alkaline in the Sioux soils and neutral in the Sverdrup soils.

Some areas of this map unit are cultivated; however, these soils are poorly suited to crop production. Small grain, sunflowers, and corn are the most common crops. Other areas of these soils are used for hayland and pasture. A smaller acreage is idle and commonly supports native and introduced grasses. A few areas are in woodland, and oak is the most common tree.

Low available water capacity is the principal limitation to use of these soils as cropland. Soil erosion by wind and water is a hazard, and improving and maintaining soil fertility are management concerns.

Practices such as returning crop residue to the soil, planting field shelterbelts, and, where possible, planting in strips on the contour hold snow cover, reduce runoff, and reduce the effects of wind on the soil and on growing crops. These practices also permit the conservation and better use of available moisture. If a suitable water source is available, irrigation can assure an adequate water supply. Nutrient levels can be raised by applying commercial fertilizers in amounts based on the results of soil testing or by adding barnyard manure.

Growth of windbreak trees is severely limited on these soils. Seedling mortality is severe. Onsite inspection helps determine which species to plant and the proper management practices to follow.

These soils are well suited to use as sites for buildings and local roads. These soils readily absorb but do not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

These soils are in capability subclass IVs.

892C—Sioux-Sverdrup complex, 6 to 18 percent slopes. These rolling and hilly soils are on uplands. The Sioux soils are excessively drained, and the Sverdrup soils are somewhat excessively drained. These soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 55 percent of this map unit is Sioux soils, and 30 percent is Sverdrup soils. The Sioux soils are typically on knobs and the upper part of side slopes. The Sverdrup soils are on the lower part of side slopes. Individual areas are irregular in shape and typically range from 6 to 70 acres.

Typically, the Sioux soils have a surface layer of very dark brown gravelly loamy sand about 8 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown gravelly coarse sand. In some areas, the surface layer is gravelly loamy sand that is light brownish gray and grayish brown.

Typically, the Sverdrup soils have a surface layer of black sandy loam about 10 inches thick. The subsoil is brown sandy loam about 4 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand. In some areas, the surface layer is black and very dark brown sandy loam more than 16 inches thick.

Included in mapping, and making up less than 15 percent of most mapped areas, are small areas of Darnen, Lohnes, and Maddock soils. Darnen soils are moderately well drained, have a thick, dark colored surface layer, and are at the base of slopes. Lohnes soils are moderately well drained and well drained. They are on positions similar to those of the Sioux and Sverdrup soils. Maddock soils also are on similar positions and are well drained. Included in mapping are small areas of soils that formed in loamy till.

Permeability of the Sioux soils is moderately rapid or rapid. The Sverdrup soils have moderately rapid permeability in the upper sediment and rapid permeability in the underlying material. Available water capacity is low in these soils, and organic matter content is moderate to low. Surface runoff is medium. Reaction in the surface layer is neutral to mildly alkaline in the Sioux soils and neutral in the Sverdrup soils.

Some areas of this map unit are cultivated; however, these soils generally are not suited to crop production, except for specialty crops or in areas where a major reclamation project has altered soil capability. Small grain, sunflowers, and corn are the most common crops. Other areas are used for hayland and pasture. A smaller acreage of these soils is idle and commonly supports native and introduced grasses. A few areas are in woodland, and oak is the most common tree.

Low available water capacity is the principal limitation to use of these soils as cropland. Soil erosion is a hazard. Improving and maintaining soil fertility are management concerns.

Practices such as returning crop residue to the soil, planting field shelterbelts, and, where possible, planting in strips on the contour hold snow cover, reduce runoff, and reduce the effect of wind on the soil and on growing crops. These practices permit the conservation and better use of available moisture. If a suitable water source is available, irrigation can assure an adequate water supply. Adding barnyard manure also improves nutrient levels.

Growth of windbreak trees for the establishment of windbreaks is severely limited on these soils. Seedling mortality is severe. Onsite inspection may be needed to help determine species to plant and proper management practices.

Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be needed in some areas. Roads constructed on these soils should be placed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

These soils readily absorb but do not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

These soils are in capability subclass VIs.

893E—Lohnes-Waukon complex, 12 to 30 percent slopes. These well drained, hilly to very steep soils are on upland landscapes. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 60 percent of this map unit is Lohnes soils, and about 25 percent is Waukon soils. The Lohnes soils are commonly on side slopes, and Waukon soils are commonly on the upper part of slopes and on knobs. Individual areas are irregular in shape and typically range from 6 to 100 acres.

Typically, the Lohnes soils have a surface layer of black loamy sand about 10 inches thick. The underlying material to a depth of about 60 inches is brown and grayish brown coarse sand.

Typically, the Waukon soils have a surface layer of black fine sandy loam about 7 inches thick. The subsoil is brown clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam.

In some areas, stones and boulders are on the surface. Some places have sandy soils that have no gravel in the underlying material. In some places, loamy till containing sand and gravel is in the underlying material. In sandy and gravelly soil, the underlying material is sometimes loamy till.

Included with these soils in mapping, and making up 5 to 15 percent of most areas, are areas of Darnen, Langhei, and Sioux soils. Darnen soils are moderately well drained, have a thicker, dark colored surface soil, and are typically at the base of slopes. Langhei soils are on knobs of slopes and breaks and have a lighter colored, more strongly calcareous surface layer. Sioux soils are excessively drained and have more gravel-size material. They are on positions similar to those of the Lohnes and Waukon soils.

Soils in this complex have rapid to moderate permeability. Available water capacity ranges from low to high. Organic matter content is moderate to low. Surface runoff is rapid or very rapid. Reaction in the surface layer typically ranges from slightly acid to neutral.

A few areas are cultivated; however, these soils are generally not suited to crop production. Small grain, corn, and sunflowers are the most common crops. Other areas are used for hay or pasture. Introduced grasses or an alfalfa-grass mix is the typical crop on these areas. Some areas are idle, and many of these support scattered trees or are moderately to heavily wooded.

The Lohnes soils are droughty, and most areas of this complex have rapid runoff and are easily eroded by water if not protected by vegetative cover.

Growth of windbreak trees is severely limited on these soils. Seedling mortality is severe. Onsite inspection helps determine which species to plant and the proper management practices to follow.

Slope is the main limitation to the use of these soils as building sites. Extensive land shaping is generally needed. Buildings and lots should be designed to conform to the natural slope of the land. Extensive cutting and filling is generally needed if roads are constructed on this soil. Roads should be placed on the contour and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

These soils are poorly suited to use as septic tank absorption fields because of the steepness of slope and because the Lohnes soils do not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field and placing distribution lines across the slope help to lessen the severity of the slope limitation and the pollution hazard.

These soils are in capability subclass VIe.

903B—Barnes-Langhei loams, 1 to 6 percent slopes. These well drained, nearly level and gently undulating soils are on upland landscapes. Areas of these soils are so small or so intricately mixed that it is not practical to separate them at the scale used in mapping. About 60 percent of this map unit is Barnes soils, and 30 percent is Langhei soils. The Barnes soils are on side slopes and slightly lower knobs and ridges. The Langhei soils are on the top of knobs and on the breaks of the upper part of slopes. Individual areas are irregular in shape and typically range from 10 to 200 acres.

Typically, the Barnes soils have a surface layer of black loam about 9 inches thick. The subsoil is brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, calcareous loam. Some areas have a dark brown surface layer less than 9 inches thick.

Typically, the Langhei soils have a surface layer of strongly calcareous, dark grayish brown loam about 8 inches thick. The next layer is very strongly calcareous, brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, yellowish brown loam.

In some places, very fine sand or fine sand is in the underlying material. Some areas have a sandy loam surface soil and subsoil. Some areas have a dark colored surface soil more than 24 inches thick. Some areas have texture of silt loam throughout the profile.

Included with these soils in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Darnen, Flom, and Kittson soils. Darnen soils are moderately well drained, have a thick, dark colored surface soil, and are commonly at the base of steeper slopes. Flom soils are poorly drained and are in swales or shallow depressions. Kittson soils are somewhat poorly drained and moderately well drained and are on slightly lower positions than the Barnes and Langhei soils.

Permeability is moderate. Available water capacity is moderate to high. Organic matter content is moderate to high in the Barnes soil and moderate to low in the Langhei soil. Surface runoff is medium. Reaction in the surface layer is neutral in the Barnes soils and moderately alkaline in the Langhei soils.

Nearly all of the acreage of these soils is cultivated, and these soils are well suited to cropland use. Small grain, sunflowers, soybeans, corn, and hay or pasture are the most common crops.

Erosion by water or wind is the principal hazard to cropping these soils. Management concerns include maintaining soil fertility and tilth. The Langhei soils in this map unit have lower natural fertility than the Barnes soils.

Returning crop residue to the soil and, where feasible, planting on the contour reduce soil erosion. In areas of concentrated flow, grassed waterways prevent the formation of rills and gullies by running water. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure help to maintain organic matter content and soil structure.

These soils are suited to most windbreak trees and shrubs that have no climatic limitation. The Langhei soils are strongly calcareous, and trees and shrubs that tolerate this condition should be planted. These soils also have less available moisture than do the Barnes soils. Seedling mortality is commonly low to moderate, and plant competition is moderate to severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

These soils are well suited to use as building sites. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by low strength and frost action. The soils in this map unit cannot readily absorb effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

These soils are in capability subclass IIe.

908—Bearden-Fargo complex. These nearly level soils are on lake plains. The Bearden soils are somewhat poorly drained, and the Fargo soils are poorly drained. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 55 percent of this map unit is Bearden soils that are typically on the low ridges. Fargo soils make up about 35 percent of most individual areas and are in shallow swales. Areas of this map unit are irregular in shape and typically range from 20 to 800 acres. The Fargo soils are subject to rare flooding.

Typically, the Bearden soils have a surface layer of strongly calcareous, very dark gray silty clay loam about 10 inches thick. The next layer is very strongly calcareous, grayish brown silty clay loam and silt loam about 19 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, mottled, grayish brown silt loam.

Typically, the Fargo soils have a surface layer of black silty clay about 10 inches thick. The subsoil is very dark gray and gray silty clay about 9 inches thick. The underlying material to a depth of about 60 inches is calcareous, mottled, gray and light olive gray silty clay loam.

Some areas are more than 50 percent Fargo soils. Some of the Fargo soils have a calcareous surface layer. In places, the Fargo soils have clayey underlying material. Some areas of the Bearden soils have a surface layer of silt loam.

Included with these soils in mapping, and making up 2 to 15 percent of most mapped areas, are areas of Wheatville soils. Wheatville soils are somewhat poorly drained and moderately well drained and are on positions similar to those of the Bearden soils.

Permeability of the Bearden soils is slow to moderate and permeability of the Fargo soil is slow. Available water capacity is moderate to high. Organic matter content is high in both the Bearden and Fargo soils. Surface runoff is slow. Reaction in the surface layer is moderately alkaline in the Bearden soils and neutral in the Fargo soils. Depth to the seasonal high water table is 1.5 to 3.0 feet.

Most areas of these soils are cultivated, and these soils are well suited to cropland use. Small grain, sunflowers, and sugar beets are the most common crops.

Wetness is the principal limitation to cropping these soils. Soil blowing may occur on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Delaying cultivation until the soil is less wet allows for preparation of a more desirable seedbed and improves cropping potential. Seeding cover crops and stubble mulching are the practices most commonly used to reduce soil blowing.

These soils are best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicide help to remove competing plants.

Buildings constructed on these soils should have the lower level constructed above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Backfilling around foundations with suitable coarse material provides additional protection against structural damage.

Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts minimize wetness and help protect the roads from damage caused by frost action and low soil strength.

These soils are poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soils do not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

These soils are in capability subclass IIw.

935—Hegne-Fargo silty clays. These poorly drained, nearly level soils are on lake plains. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 55 percent of this map unit is Hegne soils that are typically on the low ridges. About 40 percent is Fargo soils that are typically in shallow swales. Individual areas of this map unit are irregular in shape and typically range from 20 to 900 acres. These soils are subject to rare flooding.

Typically, the Hegne soils have a surface layer of strongly calcareous, black silty clay about 9 inches thick.

The next layer is about 25 inches thick. It is very strongly calcareous, silty clay and grades from dark gray to olive gray. The underlying material to a depth of about 60 inches is calcareous, olive gray, grayish brown, and dark gray silty clay and clay.

Typically, the Fargo soil has a surface layer of black silty clay about 12 inches thick. The subsoil is very dark gray silty clay about 12 inches thick. The underlying material to a depth of about 60 inches is calcareous, olive gray silty clay.

Some individual areas are made up of more than 50 percent Fargo soils. Some Fargo soils have a calcareous surface layer. In some places, the Fargo soils have texture of silty clay loam in the underlying material. A few areas of the Hegne soils have a noncalcareous surface layer but strongly calcareous material is within 16 inches of the surface. In a few places, the calcareous soils are more than 60 percent clay.

Included with these soils in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Bearden soils. Bearden soils are somewhat poorly drained and moderately well drained and formed in more silty sediment than did the Hegne and Fargo soils. They are on low ridge positions.

Permeability is slow in the Fargo soils and very slow in the Hegne soils. Available water capacity is moderate. Organic matter content is moderate to high in the Hegne soils and high in the Fargo soils. Surface runoff is slow. Reaction in the surface layer is moderately alkaline in the Hegne soils and neutral in the Fargo soils. The seasonal high water table is above 3 feet.

In most areas the Hegne and Fargo soils are cultivated and are well suited to cropland use. Small grain, sunflowers, and sugar beets are the most common crops.

Wetness is the principal limitation to cropping these soils. Soil blowing may occur on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Delaying cultivation until the soil is less wet allows for preparation of a more desirable seedbed and improves cropping potential. Seeding cover crops and stubble mulching are the practices most commonly used to reduce soil blowing.

These soils are best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicide help to remove competing plants.

These soils are poorly suited to use as building sites because of the seasonal high water table, the shrinking and swelling of the soils with changes in moisture content, and the flood hazard. If buildings are constructed on these soils, the lower level should be constructed above the seasonal high water table. Constructing tile drains around foundations helps to remove excess subsurface water. Backfilling around foundations with suitable coarse material helps protect the foundations from damage caused by shrinking and swelling of the soil. Landscaping should be designed to drain surface water away from buildings.

Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by flooding and low soil strength.

These soils are poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soils do not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

These soils are in capability subclass IIw.

942C2—Langhei-Barnes loams, 6 to 12 percent slopes, eroded. These well drained, rolling soils are on upland landscapes. About 60 percent of this map unit is Langhei soils, and 30 percent is Barnes soils. The Langhei soils are on knobs and the breaks or the upper part of slopes. The Barnes soils in this map unit are mainly on side slopes. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. Areas of this map unit are irregular in shape and commonly range from 10 to 150 acres.

Typically, the Langhei soils have a surface layer of strongly calcareous, dark grayish brown loam about 8 inches thick. The next layer is very strongly calcareous, brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, light olive brown and yellowish brown loam.

Typically, the Barnes soils have a surface layer of black loam about 8 inches thick. The subsoil is brown and yellowish brown loam about 6 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown, calcareous loam.

Some areas have very fine sand and fine sand in the underlying materials. In some areas, the surface layer is sandy loam. Some areas have a dark colored surface layer more than 24 inches thick, and in a few places, the surface layer is less than 9 inches thick. A few places have texture of silt loam in the subsoil and underlying material. Some areas have texture of silty clay loam in some or all parts of the soil profile. Small areas have sand and gravel in the underlying material.

Included with these soils in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Darnen, Flom, and Kittson soils. Darnen soils are moderately well drained, have a thicker dark colored surface soil, and occur at the base of steeper slopes than the Langhei and Barnes soils. Flom soils are poorly drained and are in swales and shallow depressions. Kittson soils are somewhat poorly drained and moderately well drained and are on slightly lower, less rolling positions.

Permeability is moderate. Available water capacity is moderate to high. Organic matter content is moderate to low in the Langhei soils and moderate to high in the Barnes soils. Surface runoff is rapid. Reaction in the surface layer is moderately alkaline in the Langhei soils and neutral in the Barnes soils.

Nearly all of the acreage of this map unit is cultivated. These soils are moderately suited to cropland use. Small grain, sunflowers, soybeans, corn, and hay or pasture are the most common crops.

Water erosion is the principal hazard to cropping these soils. This hazard is severe because these soils are already eroded (fig. 8). Maintaining or improving soil fertility and tilth is a management concern. The Langhei soils in this map unit have lower natural fertility than the Barnes soils.

Returning crop residue to the soil and, where feasible, planting on the contour reduce soil erosion. In areas of concentrated flow, grassed waterways can be used to prevent the formation of rills and gullies by running water. Returning residue to the soil, plowing under green manure crops, and adding barnyard manure help to maintain the organic matter content and the structure of the soil.

These soils are suited to most windbreak trees and shrubs that have no climatic or disease limitation. The Langhei soils are strongly calcareous, and some trees and shrubs may not tolerate this condition. Seedling mortality is commonly moderate to low, and plant competition is moderate to severe.

Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads can be constructed on well compacted, coarse textured fill material to help to protect them from damage caused by low strength and frost. Roads should be constructed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

The slope and permeability of these soils restrict them from readily absorbing effluent from septic tanks. Installing a larger than average drain field and placing

Figure 8.— Rill erosion on Langhei-Barnes loams, 6 to 12 percent slopes, eroded.

distribution lines across the slope help to overcome these limitations.

These soils are in capability subclass IIIe.

942D2—Langhei-Barnes loam, 12 to 18 percent slopes, eroded. These well drained, hilly soils are on upland landscapes. About 65 percent of this map unit is Langhei soils, and 25 percent is Barnes soils. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. Areas of this map unit are irregular in shape and commonly range from 10 to 75 acres.

Typically, the Langhei soils have a surface layer of strongly calcareous, grayish brown loam about 8 inches thick. The next layer, about 9 inches thick, is very strongly calcareous, yellowish brown and brown loam. The underlying material to a depth of about 60 inches is yellowish brown, strongly calcareous loam.

Typically, the Barnes soils have a surface layer of black loam about 9 inches thick. The subsoil is brown and yellowish brown loam about 5 inches thick. The underlying material to a depth of about 60 inches is calcareous, light yellowish brown and light olive brown loam. Some places have very fine sand, fine sand, and gravel in the underlying material. Also included are some areas that have a surface layer of sandy loam. A few places have texture of silt loam in the subsoil and underlying material. A small acreage has texture of silty clay loam in some or all parts of the soil profile.

Included with these soils in mapping, and making up less than 15 percent of most mapped areas, are small areas of Darnen, Flom, and Kittson soils. Darnen soils are moderately well drained, have a thicker dark colored surface layer than the Langhei and Barnes soils, and are at the base of steeper slopes. Flom soils are poorly drained and are in swales and shallow depressions. Kittson soils are somewhat poorly drained and moderately well drained and are on lower, less hilly positions.

Permeability is moderate. Available water capacity is moderate to high. Organic matter content is low to moderate in the Langhei soils and moderate to high in the Barnes soils. Surface runoff is very rapid. Reaction in the surface layer is moderately alkaline in the Langhei soils and neutral in the Barnes soils.

Most areas of these soils are cultivated; however, these soils are poorly suited to cropland use. Small grain and hay or pasture are the most common crops.

Water erosion is the principal hazard to cropping these soils. This hazard is severe because the complex is already eroded. Maintaining or improving soil fertility and tilth is a management concern. The Langhei soils in this map unit have lower natural fertility than the Barnes soils.

Returning crop residue to the soil and, where feasible, planting on the contour reduce soil erosion. In areas of concentrated flow, grassed waterways prevent the formation of rills and gullies by running water. Returning residue to the soil, plowing under green manure crops, and adding barnyard manure help to maintain organic matter content and soil structure.

These soils are suited to windbreak trees and shrubs that have no climatic limitation and that tolerate strongly calcareous soil. In some areas, very rapid runoff results in less available water. Seedling mortality is commonly moderate, and plant competition is moderate to severe.

Slope is the main limitation to the use of these soils as building sites. Extensive land shaping is generally needed. Buildings and lots should be designed to conform to the natural slope of the land. Extensive cutting and filling is commonly needed if roads are constructed on these soils. Roads can be placed on the contour and roadbanks can be planted to well adapted grasses to minimize the erosion hazard.

Land shaping and installation of distribution lines across the slope is generally necessary for the proper operation of septic tank absorption fields.

These soils are in capability subclass IVe.

966C—Waukon-Sioux sandy loams, 4 to 12 percent slopes. These gently undulating to rolling soils are on upland landscapes. The Waukon soils are well drained, and the Sioux soils are excessively drained. About 55 percent of this map unit is Waukon soils, and 35 percent is Sioux soils. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. Areas of this complex are irregular in shape and commonly range from 5 to 30 acres.

Typically, the Waukon soils have a surface layer of very dark brown sandy loam about 10 inches thick. The subsoil is 24 inches thick. It is dark yellowish brown sandy clay loam in the upper 10 inches and grades to yellowish brown fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and light yellowish brown fine sandy loam. In some areas, gravel is below 36 inches.

The Sioux soils typically have a surface layer of very dark brown sandy loam about 8 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown gravelly coarse sand. In some areas, gravelly outwash material is underlain by loam and fine sandy loam at a depth which ranges from 20 to 40 inches. In other areas, the loamy material is underlain by sand and gravel.

Included with these soils in mapping, and making up 5 to 15 percent of the mapped areas, are small areas of Darnen, Gonvick, and Langhei soils. Darnen soils are moderately well drained, have a thicker surface layer than the Waukon and Sioux soils, and are at the base of slopes. Gonvick soils are moderately well drained and are on slightly lower, less rolling positions. Langhei soils are on knobs and the breaks of slopes and have calcareous underlying material exposed at the surface.

Permeability is moderately rapid to rapid in the Sioux soils and moderate in the Waukon soils. Available water capacity ranges from low to high. Organic matter content is moderate to high in the Waukon soils and moderate in the Sioux soils. Surface runoff is medium to rapid. Reaction in the surface layer is slightly acid in the Waukon soils and mildly alkaline in the Sioux soils.

Some areas of these soils are cultivated; however, these soils are poorly suited to cropland use. Areas of these soils used as cropland are commonly small fields bordered by more steeply sloping landscapes or wooded areas. Small grain and corn are the most common crops. Other areas are used for hay or pasture. An alfalfa-grass mix is the typical crop on these areas. Some areas are idle, and many of these are in woodland. Oak is the most commonly grown tree species in wooded areas.

These soils are subject to soil erosion in areas that are not protected by vegetative cover. In addition, the Sioux soils are droughty. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour hold snow cover and reduce runoff and erosion. These practices also permit the conservation and better use of available moisture. Adding barnyard manure improves nutrient levels.

Growth of windbreak trees is severely limited on these soils. Seedling mortality is severe. Onsite inspection helps to determine which species to plant and the proper management practices to follow.

Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings on Waukon soils should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads constructed on these soils should be placed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard. Using well compacted, coarse textured base material helps to protect roads from damage caused by frost action and by shrinking and swelling.

These soils are poorly suited to use as septic tank absorption fields because of the steepness of slopes and because the Sioux soils do not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field and placing distribution lines across the slope helps to lessen the severity of the slope limitation and the pollution hazard.

These soils are in capability subclass IVe.

966D—Waukon-Sioux sandy loams, 12 to 18 percent slopes. These soils are on upland landscapes. The Waukon soils are well drained, and the Sioux soils are excessively drained. About 55 percent of this map unit is Waukon soils, and 35 percent is Sioux soils. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. Areas of this complex are irregular in shape and commonly range from 5 to 200 acres.

Typically, the Waukon soils have a surface layer of very dark brown sandy loam about 10 inches thick. The subsoil is 24 inches thick. It is dark yellowish brown sandy clay loam in the upper 10 inches and grades to yellowish brown fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and light yellowish brown fine sandy loam. Some areas contain up to 35 percent gravel below a depth of 36 inches. In some areas, cobblestones and stones are scattered on the surface.

The Sioux soils typically have a surface layer of very dark brown sandy loam about 8 inches thick. The subsoil is brown gravelly loamy sand about 4 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown gravelly coarse sand. In places, the gravelly outwash material is underlain by loam and sandy loam at a depth of 20 to 40 inches. A few places have slopes greater than 18 percent.

Included with these soils in mapping, and making up 5 to 15 percent of the mapped areas, are small areas of Darnen, Gonvick, and Langhei soils. Darnen soils are moderately well drained, have a thicker, darker colored surface layer than the Waukon and Sioux soils, and are at the base of slopes. Gonvick soils are moderately well drained and are on slightly lower, less rolling positions. Langhei soils are on knobs and the breaks of slopes and have calcareous underlying material exposed at the surface.

Sioux soils have moderately rapid to rapid permeability. Waukon soils have moderate permeability. Available water capacity ranges from very low in the Sioux soils to high in the Waukon soils. Organic matter content is moderate in the Sioux soils and moderate to high in the Waukon soils. Surface runoff is rapid. Reaction in the surface layer ranges from mildly alkaline in the Sioux soils to slightly acid in the Waukon soils.

Most areas are in woodland, and these areas are used for pasture or are idle. These soils are generally not suited to crop production; however, a few acres of these soils are included in cultivated fields. These fields are typically small and produce hay and pasture crops in rotation with small grain.

These soils are subject to erosion in areas that are not protected by vegetative cover. The sandy and gravelly areas of the Sioux soils are droughty. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour hold snow cover and reduce runoff. These practices permit conservation and better utilization of available moisture and reduce soil erosion. Adding barnyard manure also improves nutrient levels.

Growth of trees for the establishment of windbreaks is severely limited for these soils. Seedling mortality is severe. Onsite investigation can help to determine which species to plant and the proper management practices to follow.

Slope is the main limitation to the use of these soils as building sites. Extensive land shaping is generally needed. Buildings and lots should be designed to conform to the natural slope of the land. Extensive cutting and filling is generally needed if roads are constructed on this complex. Roads should be placed on the contour and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

These soils are poorly suited to use as septic tank absorption fields because of the steepness of slope and because the Sioux soils do not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field and placing distribution lines across the slope help to lessen the severity of the slope limitation and pollution hazard.

These soils are in capability subclass VIe.

967B2—Waukon-Langhei loams, 1 to 6 percent slopes, eroded. These well drained, nearly level to gently undulating soils are on upland landscapes. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 60 percent of this map unit is Waukon soils, and 30 percent is Langhei soils. The Waukon soils are on side slopes and some slightly lower knobs and ridges. The Langhei soils are on the top of knobs and ridges and on the breaks and upper part of slopes. Individual areas are irregular in shape and typically range from 5 to 50 acres.

Typically, the Waukon soils have a surface layer of very dark brown loam about 10 inches thick. The subsoil is dark yellowish brown sandy clay loam about 10 inches thick over yellowish brown fine sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and light yellowish brown fine sandy loam. In a few places, the surface layer is eroded and the subsoil is exposed. A few places have a lighter colored, more sandy layer directly below the surface layer.

Typically, the Langhei soils have a surface layer of strongly calcareous, dark grayish brown loam about 8 inches thick. The next layer is very strongly calcareous, brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, yellowish brown loam. A few places have up to 35 percent gravel below a depth of 36 inches.

Included with these soils in mapping, and making up less than 15 percent of most mapped areas, are small areas of Darnen, Flom, and Gonvick soils. Darnen soils are moderately well drained, have a thick, dark colored surface layer, and are at the base of steeper slopes. Flom soils are poorly drained and are in swales or shallow depressions. Gonvick soils are moderately well drained and are on slightly lower landscapes than the Waukon and Langhei soils.

Permeability is moderate. Available water capacity ranges from moderate to high. Organic matter content is moderate in the Waukon soils and moderate to low in the Langhei soils. Surface runoff is medium to rapid. Reaction in the surface layer is slightly acid in the Waukon soils and moderately alkaline in the Langhei soils.

Nearly all of the acreage of these soils is cultivated, and these soils are well suited to cropland use. Small grain, corn, soybeans, and rotation hay are the common crops.

Soil erosion is the principal hazard to cropping this map unit. The presence of coarse fragments and the strongly calcareous condition of the Langhei soils are additional limitations. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour reduce soil erosion. In areas of concentrated flow, grassed waterways prevent the formation of rills and gullies by running water. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure improve nutrient levels.

These soils are best suited to most windbreak trees and shrubs that have no climatic limitations. Trees and shrubs planted on the Langhei soils should tolerate strongly calcareous soil. The Langhei soils also have less available moisture than the Waukon soils. Seedling mortality is commonly low to moderate, and plant competition is moderate to severe.

If buildings are constructed on these soils, foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil.

The moderate permeability of these soils prevents them from readily absorbing effluent from septic tanks. Installing a larger than average drain field helps to overcome this limitation.

These soils are in capability subclass IIe.

979C2—Langhei-Waukon loams, 6 to 12 percent slopes, eroded. These well drained, rolling soils are on upland landscapes. Areas of these soils are so intricately mixed or so small that it is not practical to separate them in mapping. About 60 percent of this map unit is Langhei soils and 30 percent is Waukon soils. Langhei soils are on knobs and the breaks and upper parts of slopes. The Waukon soils are on side slopes below knobs and the sharp breaks of slopes. Areas of this complex are irregular in shape and typically range from 10 to 200 acres.

Typically, the Langhei soils have a surface layer of strongly calcareous, dark grayish brown loam about 8 inches thick. The next layer is very strongly calcareous, brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, yellowish brown loam. A few areas have a thicker, darker surface layer.

Typically, the Waukon soils have a surface layer of very dark brown loam about 8 inches thick. The subsoil is dark yellowish brown sandy clay loam in the upper 9 inches and grades to yellowish brown fine sandy loam in the lower 14 inches. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and light yellowish brown fine sandy loam. Some areas are moderately eroded, and in these areas the subsoil is exposed or mixed with the surface layer. Some areas have a thin, lighter colored, more sandy layer directly below the surface layer.

Included with these soils in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Darnen, Flom, and Gonvick soils. Darnen soils are moderately well drained, have a thick, dark colored surface layer, and are at the base of steeper slopes. Flom soils are poorly drained and are in swales and shallow depressions. Gonvick soils are moderately well drained and are on slightly lower landscape positions than the Langhei and Waukon soils.

Permeability is moderate. Available water capacity is moderate to high. Organic matter content is moderate to low in the Langhei soils and moderate in the Waukon soils. Surface runoff is medium to rapid. Reaction in the surface layer is moderately alkaline in the Langhei soils and slightly acid in the Waukon soils.

Nearly all of the acreage of these soils is cultivated, and these soils are moderately suited to cropland use. Small grain, corn, soybeans, and rotation hay are the common crops. A few areas are in permanent hayland and pasture.

Water erosion is the principal hazard to cropping these soils. Coarse fragments in the Langhei and Waukon soils and the strongly calcareous condition of the Langhei soils are limitations. Improving and maintaining soil fertility are management concerns.

Returning crop residue to the soil, seeding cover crops, and, where possible, planting on the contour reduce water erosion. In areas of concentrated flow, grassed waterways prevent the formation of rills and gullies by running water. Returning residue to the soil, plowing under green manure crops, and adding barnyard manure improve nutrient levels.

These soils are best suited to most windbreak trees and shrubs that have no climatic limitations. Trees and shrubs planted on the Langhei soils should tolerate strongly calcareous soil. The Langhei soils also have less available moisture. Seedling mortality is commonly low to moderate, and plant competition is moderate to severe.

Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil with changes in moisture content. Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by low strength and frost action. Roads should be constructed on the contour, where possible, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

The slope and moderate permeability of these soils prevent them from readily absorbing effluent from septic tanks. Installing a larger than average drain field and placing distribution lines across the slope help to overcome these limitations.

These soils are in capability subclass IIIe.

979D2—Langhei-Waukon loams, 12 to 18 percent slopes, eroded. These well drained, hilly soils are on upland landscapes. Areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping. About 65 percent of this map unit is Langhei soils and 25 percent is Waukon soils. Langhei soils are on knobs and the breaks and upper parts of slopes. Waukon soils are on side slopes. Individual areas are irregular in shape and typically range from 10 to 100 acres.

Typically, the Langhei soils have a surface layer of strongly calcareous, dark grayish brown loam about 8 inches thick. The next layer is very strongly calcareous, yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, light yellowish brown loam. Some small areas have a thicker and darker surface layer. A few places have a thin, sandy layer directly below the surface layer.

Typically, the Waukon soils have a surface layer of very dark brown loam about 8 inches thick. The subsoil is dark yellowish brown sandy clay loam about 9 inches thick. This grades to yellowish brown fine sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and light yellowish brown fine sandy loam. Some areas have a thin, lighter colored, more sandy layer directly below the surface layer. In some places, the material below a depth of 36 inches is as much as 35 percent gravel. In some areas, slope is as much as 24 percent.

Included with these soils in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Darnen, Flom, and Gonvick soils. Darnen soils are moderately well drained, have a thick, dark colored surface layer, and are at the base of steeper slopes.

Flom soils are poorly drained and are in swales and shallow depressions. Gonvick soils are moderately well drained and are on slightly lower landscape positions than the Langhei and Waukon soils.

Permeability is moderate. Available water capacity is moderate to high. Organic matter content is low in the Langhei soils and moderate in the Waukon soils. Surface runoff is rapid to very rapid. Reaction in the surface layer is moderately alkaline in the Langhei soils and slightly acid in the Waukon soils.

Most of the acreage of these soils is cultivated; however, these soils are poorly suited to crop production. Small grain, corn, and rotation hay are the common crops. A few areas are in permanent hayland and pasture.

Water erosion is the principal hazard to cropping these soils. Coarse fragments in the Langhei soils and the strongly calcareous condition of these soils are limitations. Improving and maintaining soil fertility are management concerns.

Practices such as returning crop residue to the soil, seeding cover crops, and where possible, planting on the contour reduce soil erosion. In areas of concentrated flow, grassed waterways prevent the formation of rills and gullies by running water. Returning crop residue to the soil, plowing under green manure crops, and adding barnyard manure improve nutrient levels.

These soils are best suited to most windbreak trees and shrubs that have no climatic or disease limitations. Trees and shrubs planted on the Langhei soils should tolerate strongly calcareous soil. The Langhei soils also have less available moisture. Seedling mortality is commonly low to moderate, and plant competition is moderate to severe.

Slope is the main limitation to use of these soils as building sites. Extensive land shaping is generally needed. Buildings and lots should be designed to conform to the natural slope of the land. Extensive cutting and filling is commonly needed if roads are constructed on these soils. Roads should be placed on the contour, and roadbanks should be planted to well adapted grasses to minimize the erosion hazard.

Land shaping and installing distribution lines across the slope is generally necessary for the proper operation of septic tank absorption fields.

These soils are in capability subclass IVe.

987—Rockwell loam, depressional. This very poorly drained, nearly level soil is in depressions, swales, and draws on lake-modified till plains. Individual areas of this soil are irregular in shape and typically range from 3 to 25 acres. This soil is subject to rare flooding and ponding.

Typically, the surface layer is black loam about 11 inches thick. The next layer is very strongly calcareous, gray fine sandy loam about 8 inches thick. Below this is mottled, light gray loamy sand and fine sand about 9 inches thick. The contrasting underlying material to a depth of about 60 inches is mottled, light olive gray silt loam and loam. In places, a mixing of soil material has occurred. Some areas have a thick surface layer and buried, dark colored layers. Thin, highly decomposed organic layers are in a few areas.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Arveson, Cathro, and Markey soils. Arveson soils formed entirely in sandy material. Cathro soils formed in more than 16 inches of organic material over loamy mineral material. Markey soils formed in more than 16 inches of organic material over sandy sediment. Arveson, Cathro, and Markey soils are in landscape positions similar to those of the Rockwell soils.

Permeability of this soil is moderate to moderately slow. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is ponded. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is less than 1 foot.

Much of the acreage of this soil is idle, and these areas support sedges, grasses, and lowland brush. A few areas are in woodland and provide habitat for wildlife. A few areas of this soil are included in fields that are cultivated and planted to crops such as small grain, sunflowers, and corn. This soil is moderately suited to cropland use. A large acreage is in hayland and pasture.

Wetness is the principal limitation to cropping this soil. Soil blowing may occur in areas that are dry and not vegetated. Low available water capacity in the underlying material may cause droughtiness in this soil during dry seasons. Improving and maintaining soil fertility are management concerns. Production of hayland and pasture crops can be improved by rotating pasture, delaying grazing, controlling weeds, and drainage.

Constructing open field ditches reduces wetness. The gradient of these ditches is critical, as flowing water erodes soil materials easily. Establishing grass in the ditches reduces the formation of rills and gullies by flowing water. Returning crop residue to the soil, seeding cover crops, and planting field windbreaks reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate wet and strongly calcareous soil. Seedling mortality is moderate to severe, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is generally not suited to use as building sites or septic tank absorption fields because of the flood hazard. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass IIIw.

1001—Haplaquolls and Udifluvents, level. These poorly drained, nearly level soils are on low terrace positions that most commonly are near the Buffalo River and small tributary streams. Individual areas are commonly elongated or triangular in shape and typically range from 4 to 80 acres. Slopes range from 0 to 2 percent. These soils are subject to frequent flooding.

The surface layer of a profile in these soils is calcareous, very dark gray silt loam about 10 inches thick. This is underlain to a depth of 60 inches by strongly calcareous, black, grayish brown, and dark gray silt loam and silty clay loam stratified with fine sandy loam, loamy very fine sand, very fine sandy loam, loam, and silty clay.

Included in mapping are a few higher areas that are poorly drained and somewhat poorly drained and are less subject to flooding. These soils make up 5 to 15 percent of some areas.

Permeability of these soils is moderately slow to moderately rapid. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer ranges from neutral to moderately alkaline. Depth to the seasonal high water table ranges from 1 foot to 5 feet.

Many areas of these soils are cultivated. These soils are moderately suited to crop production. Although cultivation is usually delayed, most of these areas are farmed. Small grain, sugar beets, potatoes, and sunflowers are the most common crops. A few areas are not easily accessible and are idle or used for pasture. Some of these areas are in bottom land hardwoods.

Flooding is the principal hazard to cultivating these soils. A few areas no longer flood seasonally. In these areas, soil blowing and soil wetness are management concerns affecting crop production.

Some areas of these soils can be protected by diking. Outlets can be improved to remove flood water more rapidly and completely. Installing ditches reduces the wetness limitation. Returning crop residue to the soil and planting shelterbelts are practices that reduce soil blowing.

In some areas, these soils are protected from wind by trees growing near streams. Trees and shrubs planted on these soils should tolerate wetness and short-term flooding. These soils generally are not well suited to conifers. Seedling mortality is moderate to severe. Plant competition is severe, and equipment limitations are sometimes severe. Weed control and applications of herbicides help to remove competing plants.

These soils are generally not suited to use as sites for dwellings, small commercial buildings, local roads or streets, and septic tank absorption fields. The flood hazard is the main limiting factor. Major reclamation is required to make these areas suitable for urban uses.

These soils are in capability subclass IIIw.

1005—Fluvaquents, loamy. These very poorly drained, nearly level soils are on bottom lands near streams. Areas of these soils are commonly elongated and parallel to streams or are irregularly shaped. Individual areas typically range from 4 to 70 acres. These soils are subject to frequent flooding.

The surface layer of a profile in these soils is calcareous, very dark gray mucky silt loam about 7 inches thick. The next layer is strongly calcareous, very dark gray and dark gray silt loam about 21 inches thick. The underlying material to a depth of about 60 inches is calcareous, black, dark gray, olive gray, and gray silty clay loam.

Included with these soils in mapping are small marsh areas where the soils have a thin layer of organic material. These make up 2 to 10 percent of most areas.

Permeability of these soils ranges from slow to moderately rapid. Available water capacity is high. Organic matter content is high. Surface runoff is slow, and in some areas it is ponded. Reaction in the surface layer ranges from mildly alkaline to moderately alkaline. Depth to the seasonal high water table is less than 3 feet.

Most areas of these soils are idle. These soils are generally not suited to crop production. Most areas are not accessible, and operation of farm machines is not practical. These areas are best suited to use as wildlife habitat. A small acreage is used for pasture. Many areas are in bottom land hardwoods and others support mostly lowland brush. A few places are so frequently flooded that they produce little or no vegetation.

Trees and shrubs planted on these soils should tolerate wetness and flooding. Seedling mortality and plant competition are commonly severe. Equipment limitations are severe.

These soils are not suited to use as sites for dwellings, small commercial buildings, local roads and streets, and septic tank absorption fields. Flooding is the limiting factor.

This soil is in capability subclass VIw.

1006—Fluvaquents-Haploborolls complex. These nearly level to very steep, very poorly to moderately well drained soils are on narrow slopes and breaks along major streams and on low flood plains generally adjacent to stream channels. Areas commonly extend back along side drains leading to the streams. The low areas adjacent to streams are commonly the first flooded when water leaves the main stream channels. About 60 percent of this map unit is Fluvaquents, and about 40 percent is Haploborolls. Individual areas of these soils are so small or so intricately mixed that it is not practical to separate them at the scale used in mapping. These areas are irregular in shape and typically range from 4 to 300 acres. The Fluvaquents part of this map unit is subject to frequent flooding.

These soils have texture of loam, clay loam, silty clay loam, silty clay, and clay. Included on slopes and breaks are areas of Bearden soils, Fargo soils, Wahpeton soils, and Wheatville soils. Included on flood plains are small, very wet areas of marsh vegetation. Also included are a few places with small intermittent water areas. Making up 5 to 15 percent of most mapped areas are small areas of Cashel soils, which are less subject to flooding than are most of the soils on low flood plains.

Permeability of these soils ranges from slow to moderately rapid. Both the available water capacity and the organic matter content are high. Surface runoff is rapid on areas of these soils on slopes and breaks and slow or ponded on areas of these soils on low flood plains. Reaction in the surface layer ranges from neutral to moderately alkaline. Depth to the seasonal high water table is about 6 feet.

Nearly all areas of these soils are idle, and these soils are best suited to wildlife habitat. These soils are generally not suited to crop production. Most areas of these soils on slopes and breaks are too steep or inaccessible for cultivation. Areas on low flood plains are typically too wet for cultivation and are subject to flooding. They are also commonly inaccessible, and operation of farm machines on these areas is not practical. A small acreage is used for pasture, and some areas are included in parks and other recreation areas. Many areas of these soils are in woodland, and basswood, elm, ash, and cottonwood are the most common trees.

Trees and shrubs planted on low areas of these soils should tolerate very wet soils and flooding. Seedling mortality and plant competition in these areas is commonly severe. Equipment limitations are severe on areas of these soils on slopes as well as those on low flood plains.

These soils are generally not suited to use as sites for dwellings, small commercial buildings, local roads and streets, or septic tank absorption fields. The flood hazard on bottom lands and the steepness of adjoining slopes are the principal limitations to urban uses of these soils.

These soils are in capability subclass VIw.

1029—Pits, gravel. This map unit is in areas from which gravelly material has been mined. These pits are generally associated with areas of Sioux and Lohnes soils and are in areas around beach ridges or areas of coarse textured outwash. Commonly, the surface layer has been stripped from these soils and deposited around the edges of the gravel pits. The size and shape of these pits are influenced largely by the quantity and quality of gravel found at each site. Many pits have been abandoned because the supply of suitable gravel has been exhausted. Some of the abandoned deeper pits are filled with water. At several of the larger pit sites, gravel and sand are removed from water by dragline devices. The level of water in some pits represents the water level of an aquifer.

Included in mapping are a few areas from which soil materials other than gravel and sand have been removed. These materials range in texture from sand to clay and have been mostly used for building roads and railroad grades.

Introduced and native grasses grow in and around the abandoned pits. A few scattered trees also grow on these areas. Limited grazing is available on the spoil of these pits, and water for stock is available in the deeper ones. Many abandoned pit areas also provide cover and water for wildlife. Areas of these pits can be leveled and reclaimed, but their suitability for uses will vary considerably. Onsite investigation is necessary to determine suitability of areas for desired uses.

This map unit has not been assigned to a capability subclass.

1055—Haplaquolls and Histosols, ponded. These very poorly drained, nearly level soils are in swales, depressions, and larger, slightly depressional areas. In some areas they are adjacent to streams and lakes. They are on lake plain and upland landscapes. Commonly, shallow water is ponded in these areas during most of the growing season. Individual areas of these soils are irregular in shape and typically range from 3 to 120 acres.

The surface layer of a Haplaquoll in this map unit is black clay loam about 16 inches thick. The next layer is dark gray clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is mottled, gray loam and silt loam. In places, the underlying material is stratified with layers of sandy loam or silty clay loam.

The surface layer of a Histosol in this map unit is black highly decomposed organic material about 24 inches thick. Some shell fragments are on the surface. The next layer is very dark gray, highly decomposed organic material about 18 inches thick. The underlying material to a depth of about 60 inches is olive gray clay loam. In places, the underlying material is sandy. In places, the organic surface layer is less than 16 inches thick. In other places, the plant accumulations are only partly decomposed. These soils are calcareous in places.

Permeability of these soils ranges from moderately rapid to moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is ponded. Reaction in the surface layer is typically neutral or mildly alkaline. Depth to the seasonal high water table is less than 1 foot.

Nearly all areas of these soils are idle. They are best suited to use and development as wildlife habitat. These soils provide nesting and escape areas for waterfowl and cover for fur bearers and upland game. These areas can often be managed to improve wildlife production. Management practices include water level control and fencing to limit access of livestock to these areas. These soils are generally not suited to crop production.

Trees and shrubs planted on these soils should tolerate wetness and ponding conditions. Many areas are not suited to use as woodland. Seedling mortality, plant competition, and equipment limitations are severe.

These soils are not suited to use as sites for dwellings, small commercial buildings, local roads and streets, or septic tank absorption fields. Wetness and ponding are the main limitations.

These soils are in capability subclass VIIIw.

1819—Glyndon silty clay loam. This somewhat poorly and moderately well drained, nearly level soil is on lake plains. Individual areas of this soil are irregular in shape and typically range from 10 to 200 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. This is underlain by about 10 inches of very strongly calcareous, gray and light gray silty clay loam. The next layer is strongly calcareous, mottled grayish brown silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is calcareous, mottled, olive yellow and light olive brown very fine sand. Some areas have a thinner surface layer. In places, the strongly calcareous underlying layer is mixed with the surface layer. In some areas, the surface texture is silt loam.

Included with this soil in mapping, and making up less than 15 percent of most mapped areas, are small areas of Bearden and Overly soils. Bearden soils are on landscapes similar to those of the Glyndon soils and have finer textured underlying material. Overly soils are also on similar landscapes, are noncalcareous in the upper part of the profile, and do not have very fine sand in the underlying material.

Permeability of this soil is moderate. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table is 2.5 to 6.0 feet.

Nearly all the acreage of this soil is cultivated, and this soil is well suited to cropland use. Small grain, sugar beets, soybeans, sunflowers, and potatoes are the most common crops.

A fertility imbalance caused by the strongly calcareous condition is the principal limitation to cropping this soil. If the soil is cultivated while wet, its surface becomes cloddy, and seedbed preparation may be difficult. Soil blowing is a hazard to cropping this soil.

Returning crop residue to the soil and planting field shelterbelts help to control soil blowing. These practices also help to hold and distribute snow cover, providing additional moisture for plant growth. Delaying cultivation until the surface is near the optimum moisture content for cultivation reduces damage to soil structure and prevents clodding.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIs.

1854—Wyndmere complex. This complex, which is on lake plains, consists of nearly level, somewhat poorly drained soils. The saline Wyndmere soils make up 55 to 75 percent of the complex, and the nonsaline Wyndmere soils make up 20 to 40 percent. The areas of saline soils and the areas of nonsaline soils are so small or so intricately mixed that it is not practical to separate them at the scale used in mapping. The areas of this complex are irregular in shape and typically range from l0 to l00 acres. Commonly, there is a sharp boundary between the saline and nonsaline soils. The areas of saline soils are on slightly higher positions and commonly are 50 to 200 feet wide and parallel to ditches.

Typically, these soils have a surface layer of black fine sandy loam about 8 to 10 inches thick. Small white filaments of salt crystals are commonly on and near the surface of the saline soils. The next layer is very strongly calcareous, gray fine sandy loam about 12 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous fine sandy loam that grades from light yellowish brown to mottled, light brownish gray.

Included with these soils are areas of Augsburg, Borup, and Wheatville soils. These soils in combination can make up 15 to 25 percent of the areas where saline soils are most common. Augsburg soils are poorly drained and have clayey material within 40 inches of the surface. Borup soils are poorly drained and have more very fine sand and silt in the soil material than the Wyndmere soils. Augsburg and Borup soils are on lower landscape positions. Wheatville soils are on similar landscapes but have clayey sediment within 40 inches of the surface.

The permeability of these soils is moderately rapid. Available water capacity is high. Organic matter content is moderate to high. Surface runoff is slow. Reaction in the surface layer is moderately alkaline. Depth to the seasonal high water table ranges from 2 to 4 feet.

Most areas of these soils are cultivated; however, these soils are poorly suited to crop production. Small grain, sunflowers, and sugar beets are the most common crops.

Salinity is the principal limitation to cropping these soils. In areas of the Wyndmere saline soils, crop growth is commonly reduced, and severely saline areas have no crop growth except for scattered salt tolerant plants. Soil blowing is an additional hazard. Improving and maintaining soil fertility are management concerns.

Soil salinity may be reduced by lowering the water table and leaching salts downward by percolating water. Constructing tile drains to lower the water table helps to reduce salinity. Surface salinity can be reduced to some extent by growing deep rooted crops and by mulching. Barley and sugar beets are the best crops to plant. Adding organic residue may help dilute salts, but no chemical amendment reduces salinity. Seeding cover crops, stubble mulching, and planting field windbreaks help to control soil blowing. Applying commercial fertilizers, based on the results of soil tests, improves nutrient levels (*3*).

The concentration of salts severely limits the growth of windbreak trees. Seedling mortality is severe. Onsite investigation is needed to determine which species to plant and the proper treatments to apply.

Buildings constructed on these soils should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

These soils are poorly suited to use as septic tank absorption fields because of the seasonal high water table. In some places, a mound type of absorption field may be suitable.

These soils are in capability subclass IVs.

1871—Fargo silty clay, swales. This poorly drained, nearly level soil is in slightly depressional areas on lake plains. Individual areas are elongated in shape and typically range from 20 to 300 acres. This soil is subject to ponding and rare flooding.

Typically, the surface layer is black silty clay about 11 inches thick. The subsoil is olive gray clay about 9 inches thick. The underlying material to a depth of about 60 inches is mottled, light olive gray clay. In places, the surface layer is more grayish in color. Some areas of this soil have layers that have textures of silty clay loam and less clay in the control section. A few areas have buried dark colored layers.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Colvin soils. Colvin soils are on similar landscapes, are more strongly calcareous at or near the surface, and have less clay than the Fargo soils.

Permeability of this soil is slow. Available water capacity is moderate. Organic matter content is high. Surface runoff is very slow. Reaction in the surface layer is typically neutral. Depth to the seasonal high water table is 0.5 foot to 1.0 foot.

Nearly all of the acreage of this soil is cultivated. This soil is moderately suited to cropland use. Small grain, sugar beets, sunflowers, and soybeans are the most common crops.

Wetness is the principal limitation to cropping this soil. Commonly, areas of this soil are too wet for cultivation when adjoining areas are suitably dry. Soil blowing may occur on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Cultivating this soil when it is too wet results in damage to the structure of the soil. This produces a cloddy surface and a less desirable seedbed. Delaying cultivation until this soil is at the optimum moisture level for cultivation helps prevent cloddiness and structural damage. Arranging and sizing fields to separate these wetter soils can allow for more timely and less damaging tillage operations. Minimum tillage and seeding cover crops are the practices most commonly used to reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate wet soil. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is generally not suited to use as building sites because of low soil strength, which may result in damage to structures, and the hazard of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts can help protect the roads from damage caused by ponding, frost action, and low soil strength.

This soil is generally not suited to use as septic tank absorption fields because of the ponding hazard. Soils that are better suited to this use are commonly nearby.

This soil is in capability subclass IIIw.

1872—Fargo silty clay, silty substratum. This poorly drained, nearly level soil is on low, slightly concave ridges on lake plains. Areas of this soil are commonly irregular in shape and typically range from 30 to 320 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is very dark gray silty clay about 8 inches thick. The next layer is strongly calcareous, gray and light gray silty clay about 20 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, mottled, light gray and light olive gray silty clay loam. Some areas are somewhat poorly drained. In places, silt loam and very fine sandy loam underlie the silty clay and clay upper part. In some places, the soil is shallower to the silty clay loam underlying material. In a few areas, the surface layer is calcareous.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Colvin and Bearden soils. Colvin soils are on landscapes similar to those of the Fargo soil, are strongly calcareous at or near the surface, and have upper soil layers of silty clay loam. Bearden soils are on slightly higher landscapes, are somewhat poorly drained and moderately well drained, and are strongly calcareous at or near the surface.

Permeability of this soil is slow in the upper sediment and moderately slow to moderate in the underlying material. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is 1 foot to 3 feet.

Nearly all of the acreage of this soil is cultivated. This soil is well suited to cropland use. Small grain, sugar beets, sunflowers, and soybeans are the most common crops.

Wetness is the principal limitation to cropping this soil. Soil blowing may occur on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Delaying cultivation until the soil is less wet allows the preparation of a more desirable seedbed and improves cropping potential. Minimum tillage, seeding cover crops, and stubble mulching are the practices most commonly used to reduce soil blowing. Applying commercial fertilizers based on the results of soil tests can maintain or improve nutrient levels.

This soil is best suited to windbreak trees and shrubs that tolerate wetness. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is poorly suited to use as building sites because of the natural high water table and flood hazard. Also, structural damage may result from shrinking and swelling of the soil with changes in moisture content. If buildings are constructed on this soil, the lower level should be constructed above the seasonal high water table and landscaping should be designed to drain surface water away from buildings. Installing tile drains around foundations helps to remove excess subsurface water. Foundations and footings can be designed to prevent structural damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides additional protection against structural damage.

Roads can be constructed on well compacted, coarse textured fill material to help protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not readily absorb effluent. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIw.

1873—Fargo silty clay, silty substratum, swales. This poorly drained, nearly level soil is in slightly depressed areas on lake plains. Individual areas are elongated in shape and typically range from 20 to 150 acres. This soil is subject to ponding and rare flooding.

Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is very dark gray silty clay about 8 inches thick. The next layer is calcareous, gray silty clay about 12 inches thick. The underlying material to a depth of about 60 inches is strongly calcareous, light olive gray silty clay loam. In places, the surface layer is more grayish in color. Some areas have silt loam and very fine sandy loam in the underlying material. A few places have buried dark colored layers.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Colvin soils. Colvin soils are on slightly higher landscape positions, are strongly calcareous at or near the surface, and have less clay in the upper sediment than the Fargo soil.

Permeability of this soil is slow in the upper sediment and moderately slow to moderate in the underlying material. Available water capacity is moderate to high. Organic matter content is high. Surface runoff is very slow. Reaction in the surface layer is neutral. Depth to the seasonal high water table is less than 2 feet.

Nearly all of the acreage of this soil is cultivated. This soil is moderately suited to cropland use. Small grain, sugar beets, soybeans, and sunflowers are the most common crops.

Wetness is the principal limitation to cropping this soil. Commonly, areas of this soil are too wet for cultivation when adjoining areas are suitably dry. Soil blowing may occur on cultivated areas that have no vegetative cover. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches reduces wetness. Cultivating this soil when it is wet may cause damage to soil structure. This produces a cloddy surface condition and a less desirable seedbed. Delaying cultivation until this soil is at the optimum moisture level for cultivation helps prevent cloddiness and structural damage. Arranging and sizing fields to separate the wetter soils can allow for more timely and less damaging tillage operations. Minimum tillage and seeding cover crops are the practices most commonly used to reduce soil blowing.

This soil is best suited to windbreak trees and shrubs that tolerate wetness. Seedling mortality on this soil is moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

This soil is generally not suited to use as building sites because of the ponding and flooding. Damage to structures may result because of shrinking and swelling of the soil with changes in moisture content. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding, frost action, and low soil strength.

This soil is generally not suited to use as septic tank absorption fields because of the ponding hazard. Soils that are better suited to this use are commonly nearby.

This soil is in capability subclass IIIw.

1874—Lohnes sandy loam. This moderately well drained, nearly level soil is on beach ridges and outwash plains. It is typically on lower side slopes of ridges and shallow swales. Individual areas of this soil are irregular in shape and typically range from 10 to about 100 acres.

Typically, the surface layer is black sandy loam about 14 inches thick. The subsoil is very dark grayish brown loamy sand grading with depth to dark yellowish brown sand. The subsoil is about 9 inches thick. The underlying material to a depth of about 60 inches is pale brown gravelly coarse sand grading with depth to mottled, light brownish gray coarse sand and mottled, light brownish gray sand. In places, the dark colored surface layer is greater than 16 inches thick. Some places have a calcareous surface layer. In a few areas, the underlying material is more gravelly. In some areas, loamy material is at a depth below 36 inches. In a few areas, scattered stones and boulders are on the surface and in the upper part of the profile.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Flaming and Maddock soils. Flaming soils are somewhat poorly drained and moderately well drained and do not have significant amounts of gravel and coarse sand in the underlying material. They are on landscape positions similar to or lower than those of the Lohnes soils. Maddock soils are well drained, typically are on slightly higher positions, and do not have significant amounts of gravel and coarse sand in the underlying material.

Permeability of this soil is rapid. Available water capacity is low. Organic matter content is moderate to high. Surface runoff is slow. Reaction in the surface layer is mildly alkaline.

Some areas of this soil are cultivated; however, this soil is poorly suited to cropland use. Small grain, sunflowers, and corn are the most common crops. A large acreage is used for hayland and pasture. Other areas are idle and support introduced and native grasses and, in places, trees or brush. A few areas of this soil have been or are presently a source of sand and gravel for roadbuilding, road surfacing, and other construction related uses.

Although some soil moisture is available from the water table, a low available water capacity in this soil is the principal limitation to cropping. Soil blowing is an additional concern on cultivated areas. Improving and maintaining soil fertility are additional management concerns.

Returning crop residue to the soil, minimum tillage, and planting field shelterbelts hold snow cover and reduce the drying effect of wind, permitting the conservation and better use of available water. These practices also help to control soil blowing. Adding barnyard manure provides some protective residue and increases fertility levels. If a water supply is available, irrigation may assure adequate moisture for plant growth. Production of pasture and hay crops can be increased by rotating pasture, delaying grazing, and controlling weeds.

This soil is best suited to windbreak trees and shrubs that tolerate some drought. In some seasons, droughty conditions may result in moderate to severe seedling mortality.

This soil is well suited to use as sites for buildings and local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water supplies. Installing a larger than average drain field lessens the severity of this hazard.

This soil is in capability subclass IVs.

1875—Flom clay loam, depressional. This very poorly drained, nearly level soil typically is in depressions on the upland. Individual areas of this soil are irregular in shape and typically range from 3 to 200 acres. This soil is subject to rare flooding and ponding.

Typically, the surface layer is black clay loam about 9 inches thick. The next layer is dark gray clay loam and silty clay loam about 17 inches thick. The underlying material to a depth of about 60 inches is olive clay loam grading to strongly calcareous, mottled, light olive gray loam. In places, this soil is calcareous throughout. Some areas have a thin, highly decomposed organic surface layer.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Rockwell soils. Rockwell soils are in similar positions and are more calcareous at or near the surface than the Flom soils.

Permeability of this soil is moderately slow. Both the available water capacity and the organic matter content are high. Surface runoff is very slow or ponded. Reaction in the surface layer is neutral. Depth to the seasonal high water table is less than 2 feet.

Much of the acreage of this soil is idle and supports wetland grasses, sedges, and lowland brush. These areas provide habitat for wildlife. Some areas are cultivated. Small grain, sunflowers, and corn are the most common crops.

Wetness is the principal limitation to cropping this soil. Ponding of runoff from adjacent upland areas is a management concern. Improving and maintaining soil fertility are management concerns.

Constructing open field ditches and deepening natural water courses reduce excess water, thus reducing the wetness limitation.

This soil is best suited to windbreak trees and shrubs that tolerate wetness. Seedling mortality is moderate to severe, and plant competition is severe.

This soil is generally not suited to building sites or septic tank absorption fields because of the hazard of flooding and ponding. Soils that are better suited to these uses are commonly nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding, frost action, and low soil strength.

This soil is in capability subclass IIIw.

1876—Divide loam, loamy substratum. This somewhat poorly and moderately well drained, nearly level soil is along remnant shore lines on lake-washed till plains. It is commonly on slightly convex positions. Individual areas of this soil are irregular in shape and typically range from 5 to 30 acres.

Typically, the surface layer is strongly calcareous, black loam about 13 inches thick. The next layer is very strongly calcareous, dark gray loam about 8 inches thick. The underlying material to a depth of about 44 inches is strongly calcareous, light brownish gray gravelly sand. Below this, to a depth of about 60 inches, is contrasting material that is strongly calcareous, olive gray loam. Some places have thicker gravel and sand deposits and do not have the contrasting underlying loam. Some areas have less gravel in the underlying material.

Included with this soil in mapping, and making up 5 to 15 percent of most mapped areas, are small areas of Foxhome and Osakis soils. Foxhome soils have a thinner upper mantle that is noncalcareous. Osakis soils are noncalcareous in the surface layer. Foxhome and Osakis soils typically are on similar landscape positions.

Permeability of this soil is moderate. Both the available water capacity and the organic matter content are high. Surface runoff is slow. Reaction in the surface layer is mildly alkaline. Depth to the seasonal high water table is 2.5 to 5.0 feet.

Many areas of this soil are cultivated. This soil is moderately suited to cropland use. Small grain, sunflowers, and corn are the most common crops. Some areas are in hay and pasture. A few areas are idle.

The calcareousness and moderate available water capacity are the primary limitations to the use of this soil as cropland. The gravel layer in this soil may also limit development and penetration of roots. Improving and maintaining soil fertility are management concerns.

Minimum and rough tillage, leaving residue on the surface, growing cover crops, and planting field windbreaks control snow blowing. As a result, snow remains on fields, providing moisture for plant growth.

This soil is best suited to windbreak trees and shrubs that tolerate strongly calcareous soil. Some drought tolerance is also desirable, as this soil has low available water capacity in the underlying layers. Seedling mortality is slight to moderate, and plant competition is severe. Weed control, cultivation, and applications of herbicides help to remove competing plants.

Buildings constructed on this soil should have the lower level constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Roads can be constructed on well compacted, coarse textured fill material to help protect them from frost damage.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies. In some places, a mound type of absorption field may be suitable.

This soil is in capability subclass IIIs.

Prime farmland

Prime farmland is one of several kinds of important farmlands defined by the U. S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited, and the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the use of our nation's prime farmland with wisdom and foresight.

Prime farmland, as defined by the U. S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland may now be in crops, pasture, woodland, or other land, but not urban and built-up land or water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. It also has favorable temperature and growing season and acceptable reaction. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. For more detailed information on the criteria for prime farmland consult the local staff of the Soil Conservation Service.

About 468,366 acres, or nearly 70 percent of Clay County, meets the soil requirements for prime farmland. Areas are scattered throughout the county, but most are in associations 1, 2, 3, 4, 7, and 8 of the general soil map. Approximately 421,529 acres of this prime farmland is used for crops.

Soil map units that make up prime farmland in Clay County are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

Soils that have a limitation— a high water table or flooding— may qualify as prime farmland if the limitation is overcome by such a measure as drainage or flood control. In the following list, these limitations, if any, are shown in parentheses after the map unit name. Onsite evaluation is necessary to determine if these limitations have been overcome by corrective measures.

The following map units meet the soil requirements for prime farmland:

33B	Barnes loam, 1 to 3 percent slopes
33B2	Barnes loam, 2 to 6 percent slopes, eroded
36	Flom clay loam (where drained)
38B	Waukon fine sandy loam, 1 to 6 percent slopes
38B2	Waukon loam, 2 to 6 percent slopes, eroded
46	Borup loam (where drained)
47	Colvin silty clay loam (where drained)
50	Cashel silty clay (where adequately protected from flooding)
52	Augsburg silt loam (where drained)
56	Fargo silty clay loam (where drained)
57A	Fargo silty clay, 0 to 2 percent slopes (where drained)
57B	Fargo silty clay, 2 to 6 percent slopes (where drained)
58A	Kittson fine sandy loam, 0 to 2 percent slopes
58B	Kittson loam, 1 to 5 percent slopes
59	Grimstad fine sandy loam (where drained)
60A	Glyndon loam, 0 to 2 percent slopes (where drained)
60B2	Glyndon loam, 2 to 6 percent slopes, eroded (where drained)
63	Rockwell clay loam (where drained)
67A	Bearden silt loam, 0 to 2 percent slopes (where drained)
67B2	Bearden silt loam, 2 to 6 percent slopes, eroded (where drained)
93	Bearden silty clay loam (where drained)
157A	Wahpeton silty clay, 0 to 2 percent slopes

157B	Wahpeton silty clay, 2 to 6 percent slopes
180B	Gonvick clay loam, 1 to 4 percent slopes
184B	Hamerly loam, 1 to 4 percent slopes (where drained)
236	Vallers loam (where drained)
293B	Swenoda sandy loam, 1 to 4 percent slopes
343A	Wheatville silt loam, 0 to 2 percent slopes (where drained)
343B2	Wheatville loam, 2 to 6 percent slopes, eroded (where drained)
403	Viking sandy clay loam (where drained)
425	Donaldson fine sandy loam
429	Northcote clay (where drained)
494	Darnen loam
506	Overly silty clay loam
508	Wyndmere fine sandy loam (where drained)
510	Elmville fine sandy loam
903B	Barnes-Langhei loams, 1 to 6 percent slopes
908	Bearden-Fargo complex (where drained)
935	Hegne-Fargo silty clays (where drained)
967B2	Waukon-Langhei loams, 1 to 6 percent slopes, eroded
1819	Glyndon silty clay loam (where drained)
1871	Fargo silty clay, swales (where drained)
1872	Fargo silty clay, silty substratum (where drained)
1873	Fargo silty clay, silty substratum, swales (where drained)

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; for windbreaks, and enviromental plantings; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and pasture

By Robert W. Kloubec, district conservationist, Soil Conservation Service.

This section describes the major management concerns in the use of the soils in Clay County for crops and pasture. It discusses the crops or pasture plants best suited to the soils, including some not commonly grown in the survey area; explains the system of land capability classification used by the Soil Conservation Service; and presents the estimated yields of the main crops and hay and pasture plants for each soil. This information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1979, more than 595,000 acres in the county was used as cropland and pasture. Of this total, 217,000 acres was in row crops, mainly sunflowers, sugar beets, and soybeans; 309,000 acres was in close-growing crops, mainly wheat, barley and oats; 30,000 acres was in rotation hay and pasture; and 35,000 acres was in permanent pasture. The rest was idle cropland.

The soils in Clay County have good potential for increased food production. About 22,000 acres currently used as pasture could be converted to cropland. In addition, the productivity of agricultural land could be realized by extending the latest crop production technology to all cropland. Using the information in this soil survey can greatly facilitate the application of such technology.

The acreage in crops and pasture is gradually decreasing as more and more land is used for urban development. In 1979, an estimated 19,000 acres was in urban and built-up land. The acreage of such land has been growing at the rate of about 600 acres per year. This soil survey can help planners make land use decisions that will minimize the loss of farmland to nonagricultural uses.

Soil erosion by water action is a major problem on about half of the cropland in Clay County. It is a common hazard on the undulating and steeper areas of soils such as Barnes, Langhei, and Waukon.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil or underlying material is incorporated into the plow layer. Soil erosion is especially damaging to soils which have a sandy surface layer and low or moderate available water capacity. Some of the soils most susceptible to erosion by wind are the Dickey, Flaming, Foldahl, Lohnes, Maddock, Poppleton, Swenoda, Ulen, and Wyndmere soils. Second, soil movement by wind or water action may result in sediment entering streams. Controlling erosion minimizes the pollution of streams caused by sediment and improves the quality of water for commercial use, for recreation, and for fish and wildlife. Practices that control erosion may also increase available moisture by reducing runoff, holding snow cover, and increasing the infiltration rate.

A cropping system that keeps plant cover on the soil for extended periods can hold soil loss to a rate that does not reduce the productive capacity of the soils. On farms that produce livestock, including legumes and grasses in the cropping system reduces the hazard of erosion on sloping and sandy soils and improves fertility and soil tilth.

On much of the upland landscape in eastern Clay County, the slopes are so short and irregular that contour tillage is difficult and diversions and terraces are difficult to design and construct. A few contour strips are on this landscape, but they are not suited to the operation of large farm machinery. Minimizing tillage and leaving crop residue on the surface reduce movement of soil by wind and water action on most soil areas used for crop production. Rough tillage and field windbreaks also aid in controlling soil blowing and holding snow cover.

Information about the design of erosion control practices for each kind of soil is contained in the Technical Guide available at the local office of the Soil Conservation Service.

Soil wetness is the major limitation on about 40 percent of the acreage used for crops in the county. Some soils are naturally so wet that producing crops common to the area is not possible unless artificial drainage has been provided. These include the very poorly drained and poorly drained Arveson, Augsburg, Borup, Colvin, Fargo, Flom, Fossum, Hegne, Northcote, Quam, Rockwell, Vallers, and Viking soils. Draining the areas of organic soils and mucks is generally not economically feasible.

Open field ditches are commonly used to reduce wetness. Many miles of drainage ditches have been installed on Clay County soils. Approximately 75 percent of the wet soils have been drained.

Information concerning the design of drainage systems for each kind of soil is contained in the Technical Guide available at the local office of the Soil Conservation Service.

Soil fertility is naturally medium or high in most soils in the county; however, Langhei soils and some of the sandy soils that formed in peats and mucks have low natural fertility. The majority of the soils are mildly or moderately alkaline. Other soils typically have a neutral surface layer. These soils include Barnes, Fargo, Flom, Gonvick, Kittson, Lohnes, Maddock, Overly, and Sverdrup. A few soils, including the Poppleton, Waukon, and Wahpeton soils, have a slightly acid surface layer.

Crops on most of the soils in the county respond to fertilizer. The kinds and amounts of fertilizer needed depend on the kind of soil, its past and present management, and the crops grown. Soil tests provide part of the information needed to choose the proper composition and application rates for fertilizer.

Maintaining good soil structure and tilth is important in preparing a desirable seedbed. Soils that have good structure or tilth are granular and porous. Regular applications of crop residue, manure, and other organic materials can improve soil structure. Cultivating moderately fine and fine textured soils when they are wet damages soil structure and makes seedbed preparation difficult.

Row crops grown in Clay County include corn, soybeans, sunflowers, sugar beets, and potatoes. The most common close-growing crops are wheat, barley, and oats. Alfalfa or an alfalfa-bromegrass mix is the most common crop grown for hay. Alfalfa-bromegrass, orchardgrass, and timothy are the most common crops grown for pasture. Some areas of native or introduced grasses are also harvested for hay or used for pasture. The most common grass plants are introduced junegrass, redtop, and quackgrass. Specialty crops grown in the county include vegetables, small fruit, and tree fruit. They are generally grown by home gardeners and by a few commercial gardens and fruit farms. The latest information about growing special crops can be obtained from local offices of the Agricultural Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, has a high pH, or is stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is cold and is characterized by a short growing season.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

Windbreaks and environmental plantings

The original woodlands in Clay County were mainly in the southeastern and east-central parts of the county. Other wooded areas were in narrow bands along the major streams. Tall prairie grass grew on the nonwooded areas.

In Clay County, trees and shrubs are presently more important for windbreaks and beautification than for commercial forest products. In some wooded areas, wood from windfalls or from trees cut when areas are thinned or cleared is used as fuel for heating.

Field windbreaks were first planted on mostly sandy, dry soils during the soil blowing that occurred during the 1930's. Plantings have since been established in all parts of the county for the purposes of beautification, wildlife habitat, and recreation.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

Clay County offers a variety of recreational opportunities. Camping, hiking, boating, hunting, fishing, snowmobiling, and nature study are the most common activities. The major recreational areas in the county are Buffalo River State Park, two county parks, 1,680 acreas of Nature Conservancy land, 6,757 acreas managed by the Department of the Interior, and 5,409 acreas of state-owned management areas. One of the county parks, the Hudson Bay Trading Post Park near Georgetown, has historical significance. Moorhead, Dilworth, Glyndon, Barnesville, Hawley, and Ulen all have community parks and picnic areas. Several privately and publicly owned golf courses are in the county.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. Soil characteristics also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

Most of the soils on the lake plain west of Minnesota Highway 9 are under intense cultivation. In this part of the county, nesting areas and woody cover are generally on a relatively small acreage along rivers and streams, near farmsteads, along road ditches, and in field windbreaks. Wildlife populations of most species are lower on this lake plain landscape. White-tailed deer populations are mainly associated with wooded areas along the Red and Buffalo Rivers. Some fur bearing animals are also in these areas. A few game birds, such as the Hungarian partridge, find cover and food along ditches and in farmstead or field windbreaks.

The soils on beaches, interbeaches, and outwash plains have slopes that range from nearly level to very steep. The soils on the higher areas are commonly sandy or gravelly, and some areas have numerous stones and boulders. Some wet soils, marshes, water areas, and intermittent streams are associated with the coarse textured soils. In this part of the county, less of the land is good agricultural land, and many areas are used for hay and pasture or are idle. Grass, brush, and wooded areas provide cover and food for upland game. Suitable habitat for some waterfowl and fur bearers is around marshes and near water areas and streams. Beach and interbeach landscapes also provide habitat for a large herd of white-tailed deer and some prairie chickens.

Soils on the upland landscape in the eastern third of the county vary considerably in slope, drainage, and other characteristics. These variations prevent the cultivation of some land areas. Non-cultivated areas that are wooded, brushy, covered by grass, or marshy provide habitat for wildlife. White-tailed deer are common, mainly in or near wooded areas. This area is also fair habitat for ruffed grouse. Marshes and small lakes provide cover, nesting, and feeding for waterfowl. This landscape has an abundant population of fur bearers.

The most common game species in Clay County are ducks, geese, gray partridge, rabbit, red fox , gray squirrel, and white-tailed deer. Pheasant numbers are commonly low. Muskrat, mink, and beaver are the most common fur bearers trapped.

The county has over 16,700 acres of Type 3, 4, and 5 wetlands. Type 3 wetlands are inland shallow freshwater marshes. Type 4 wetlands are inland deep freshwater marshes that are permanently flooded. Type 5 wetlands are inland open freshwater marshes with submerged aquatic and fringe marsh vegetation. These wetlands are interrelated and all must be preserved in order to protect the habitat for waterfowl and other wetland wildlife.

Public fishing is available in the Red and Buffalo Rivers and some small lakes. The most commonly sought fish are walleye, northern pike, perch, bullhead, and pan fish.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, elm, basswood, dogwood, green ash, and honeysuckle. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, chokecherry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. A few are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include prairie chicken, pheasant, Hungarian partridge, meadowlark, field sparrow, jack rabbit, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include gray partridge, ruffed grouse, thrushes, woodpeckers, cottontail, squirrels, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 40 inches below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains as much as 15 or 20 percent of particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*4*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, and fine sands, and very fine sands. These soils are generally poorly suited to crops. They are extremely erodible, and vegetation is often difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months;

November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 16, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, frigid Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*3*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*5*). Unless otherwise stated, matrix colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Arveson series

The Arveson series consists of deep, poorly drained and very poorly drained soils that have moderately rapid permeability. These soils formed in calcareous loamy lacustrine sediment over sandy material. They are on flats or in slight depressions on glacial lake plains and outwash plains. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Arveson soils are commonly adjacent to Flaming, Markey, Rockwell, and Ulen soils. They are similar to Borup soils. Flaming soils are on higher, typically convex landscape positions and are somewhat poorly drained or moderately well drained. Markey soils are very poorly drained and are in low swales and depressions. Rockwell soils typically are on landscape positions similar to Arveson soils. They differ by having a IIC horizon of loamy or silty glacial till or lacustrine sediment within 40 inches of the surface. Ulen soils are somewhat poorly drained and moderately well drained and are on slightly higher, convex landscapes. Borup soils are coarse-silty.

Typical pedon of Arveson clay loam, 660 feet west and 165 feet north of the SE corner of sec. 25, T. 142 N., R. 46 W.:

A11—0 to 8 inches; black (10YR 2/1) clay loam; dark gray (10YR 4/1) dry; weak fine granular structure; very friable; slightly sticky; few boulders; mildly alkaline; strong effervescence; gradual smooth boundary.

A12ca—8 to 14 inches; very dark gray (2.5Y 3/1) clay loam, gray (5Y 5/1) dry; weak very fine granular structure; very friable; slightly sticky; moderately alkaline; violent effervescence; gradual wavy boundary.

C1gca—14 to 25 inches; convolutions of light gray (5Y 7/1) and very dark gray (2.5Y 3/1) loam; weak very fine granular structure; very friable; slightly sticky; moderately alkaline; violent effervescence; clear wavy boundary.

C2gca—25 to 34 inches; gray (5Y 6/1) sandy loam; weak very fine subangular blocky structure; very friable; moderately alkaline; violent effervescence; clear smooth boundary.

C3g—34 to 46 inches; gray (5Y 6/1) loamy sand; few fine pale olive (5Y 6/3) mottles; weak very fine subangular blocky structure; very friable; moderately alkaline; strong effervescence; clear smooth boundary.

C4—46 to 60 inches; light olive gray (5Y 6/2) fine sand; few fine distinct olive yellow (2.5Y 6/8) mottles; single grain; loose; moderately alkaline; slight effervescence.

The mollic epipedon ranges from 7 to 24 inches in thickness. Depth to loamy fine sand or coarser sediment is more than 20 inches.

The A horizon is neutral and has value of 2 or 3, or it has hue of 5Y, 2.5Y, or 10YR, value of 2 or 3 (3 through 5, dry), and chroma of 1. It has mottles in a few pedons. The A horizon is sandy loam, fine sandy loam, sandy clay loam, silt loam, loam, or clay loam. It is mildly alkaline or moderately alkaline.

The Cca horizon has hue of 2.5Y or 5Y, value of 4 through 7 (6 through 8, dry), and chroma of 1 or 2. It has mottles in some pedons. The Cca horizon is sandy loam, fine sandy loam, sandy clay loam, or loam. In some pedons the lower part has texture of loamy sand or loamy fine sand. The horizon is mildly alkaline or moderately alkaline.

The part of the C horizon below the Cca has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It typically has mottles. Texture in this part of the C horizon is sand, fine sand, loamy sand, loamy fine sand, sandy loam, and fine sandy loam. Reaction is mildly alkaline or moderately alkaline.

Augsburg series

The Augsburg series consists of deep, poorly drained soils. These soils formed in a mantle of loamy sediment over lacustrine sediment that is dominantly clayey. They are on lake plains. They have moderately rapid permeability in the upper sediment and slow permeability in the underlying material. Slopes range from 0 to 2 percent. These soils are rarely flooded.

Augsburg soils are similar to Borup soils and are commonly adjacent to Elmville, Glyndon, and Wheatville soils. Borup soils do not have clayey sediment within 40 inches of the surface. Elmville soils are somewhat poorly drained and moderately well drained and are on slightly higher, generally slightly convex positions. Glyndon and Wheatville soils are somewhat poorly drained and moderately well drained and are on slightly higher landscape positions.

Typical pedon of Augsburg silt loam, 1,980 feet east and 660 feet south of the NW corner of sec. 14, T. 140 N., R. 47 W.:

Ap—0 to 10 inches; black (10YR 2/1) silt loam; very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; many fine roots; moderately alkaline; strong effervescence; abrupt smooth boundary.

C1ca—10 to 18 inches; gray (2.5Y 5/1) silt loam; weak very fine granular structure; very friable; many fine roots; moderately alkaline; violent effervescence; clear smooth boundary.

C2ca—18 to 22 inches; gray (2.5Y 5/1) very fine sandy loam; weak very fine subangular blocky structure; very friable; few fine roots; moderately alkaline; violent effervescence; clear smooth boundary.

C3—22 to 31 inches; light brownish gray (2.5Y 6/2) very fine sandy loam; common fine distinct olive yellow (2.5Y 6/6) and brownish yellow (10YR 6/8) mottles; weak fine angular blocky structure; very friable; moderately alkaline; moderate effervescence; abrupt smooth boundary.

IIC4—31 to 44 inches; olive gray (5Y 5/2) silty clay; many fine and medium prominent brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; weak very fine subangular blocky structure; sticky; moderately alkaline; strong effervescence; clear smooth boundary.

IIC5—44 to 60 inches; olive gray (5Y 4/2) silty clay loam; thin light olive gray (5Y 6/2) silt bands; many medium prominent brown (7.5YR 4/4 and strong brown (7.5YR 5/6) mottles; massive; sticky; moderately alkaline; strong effervescence.

The mollic epipedon ranges from 7 to 18 inches in thickness. Depth to the IIC horizon ranges from 20 to 40 inches. Reaction is mildly alkaline or moderately alkaline to a depth of 40 inches or more.

The A horizon has value of 2 or 3 and chroma of 1 or 2. In some pedons it is neutral and has value of 2 or 3. Texture is loam, silt loam, sandy clay loam, or very fine sandy loam.

The C horizon above the IIC has hue of 10YR, 2.5Y, or 5Y, value of 4 through 6, and chroma of 1 or 2. In some pedons this horizon has no mottles. Texture is loam, very fine sandy loam, silt loam, loamy very fine sand, or sandy clay loam. The IIC horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. Mottling ranges from faint to prominent. Texture is silty clay, clay, and silty clay loam.

Barnes series

The Barnes series consists of deep, well drained, moderately permeable soils. These soils formed in loamy glacial till on upland landscapes. Slopes range from 1 to 18 percent.

Barnes soils are commonly adjacent to Darnen, Hamerly, Kittson, and Langhei soils. They are similar to Waukon soils. Darnen soils are moderately well drained and are at the base of steeper slopes. Hamerly and Kittson soils are somewhat poorly drained and moderately well drained and are on slightly lower and typically less sloping areas. Langhei soils are somewhat excessively drained and are on slightly higher areas and the breaks of slopes. Waukon soils have an argillic horizon.

Typical pedon of Barnes loam, 1 to 3 percent slopes, 139 feet south and 1,667 feet east of the NW corner of sec. 5, T. 140 N., R. 44 W.:

Ap—0 to 9 inches; black (10YR 2/1) loam; very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; very friable; many roots; neutral; abrupt smooth boundary.

B2—9 to 13 inches; brown (10YR 4/3) loam; weak very fine subangular blocky structure; very friable; many roots; few black streaks from earthworm activities; neutral; clear smooth boundary.

B3—13 to 18 inches; yellowish brown (10YR 5/4) loam; weak very fine granular structure; very friable; about 2 percent coarse fragments; many roots; neutral grading to mildly alkaline with depth; moderate effervescence in lower 2 inches; clear wavy boundary.

C1ca—18 to 25 inches; light yellowish brown (10YR 6/4) loam; weak very fine granular structure; very friable; about 3 percent coarse fragments; many roots; moderately alkaline; violent effervescence; gradual smooth boundary.

C2ca—25 to 32 inches; pale brown (10YR 6/3) loam; few fine faint pinkish white (7.5YR 8/2) lime threads; weak fine and medium subangular blocky structure; very friable; about 2 percent coarse fragments; few roots; moderately alkaline; violent effervescence; gradual smooth boundary.

C3—32 to 60 inches; light olive brown (2.5Y 5/4) loam; many medium distinct white (2.5Y 8/2) lime masses; weak and moderate fine angular blocky structure; friable; about 2 percent coarse fragments; moderately alkaline; strong effervescence.

Thickness of the solum ranges from 10 to 23 inches. Thickness of the mollic epipedon ranges from 7 to 16 inches. Content of coarse fragments ranges from 2 to 10 percent.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1. It is dominantly loam, but textures of sandy loam, fine sandy loam, sandy clay loam, silt loam, and clay loam are within the range.

The B horizon has value of 2 through 5 and chroma of 2 through 4. It is loam, sandy clay loam, or clay loam. Few to common thin clay films are on the ped faces in some pedons. A B3 horizon that has hue of 2.5Y is in some pedons.

The Cca horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is 10 to 30 percent carbonates. The lower part of the C horizon has value of 3 through 5 and chroma of 2 through 4. In some pedons this horizon has few to many mottles.

Bearden series

The Bearden series consists of deep, somewhat poorly drained, slowly to moderately permeable soils. These soils formed in calcareous, lacustrine, dominantly silty material on lake plains. Slopes range from 0 to 6 percent.

Bearden soils are commonly adjacent to Colvin, Fargo, Overly, and Wheatville soils. They are similar to Glyndon and Hamerly soils. Colvin and Fargo soils are poorly drained and are on lower positions. Overly soils do not have a calcic horizon within 16 inches of the surface and are on higher, terracelike positions. Wheatville soils are coarse-silty over clayey and are on similar landscape positions. Glyndon soils are coarse-silty. Hamerly soils are fine-loamy.

Typical pedon of Bearden silty clay loam, 240 feet north and 2,110 feet west of the SE corner of sec. 33, T. 141 N., R. 47 W.:

Ap—0 to 12 inches; black (N 2/0) silty clay loam; very dark gray (10YR 3/1) dry; common light brownish gray (2.5Y 6/2) flecks of carbonate masses; weak very fine subangular blocky structure; very friable; many roots; moderately alkaline; strong effervescence; abrupt smooth boundary.

C1ca—12 to 24 inches; grayish brown (10YR 5/2) silty clay loam; many medium pockets of light gray (10YR 7/2) gypsum crystals; weak fine angular blocky structure; very friable; few roots; moderately alkaline; very strong effervescence; gradual smooth boundary.

C2ca—24 to 31 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; very friable; moderately alkaline; strong effervescence; gradual smooth boundary.

C3—31 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine and medium distinct light olive brown (2.5Y 5/4) and brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; friable; moderately alkaline; moderate effervescence; gradual smooth boundary.

C4—44 to 55 inches; grayish brown (2.5Y 5/2) silt loam; many medium distinct light olive brown (2.5Y 5/4) and many medium prominent brown (7.5YR 4/4) mottles; weak medium subangular blocky structure parting to weak fine platy; very friable; moderately alkaline; strong effervescence; clear smooth boundary.

C5—55 to 60 inches; light gray (2.5Y 5/2) silt loam; many medium and large prominent olive yellow (2.5Y 6/8), yellowish brown (10YR 5/8), and dark yellowish brown (10YR 4/4) mottles; weak fine platy structure becoming massive with depth; moderately alkaline; strong effervescence.

The mollic epipedon ranges in thickness from 7 to 20 inches. The Ap or A1 horizon is neutral and has value of 2, or it has hue of 10YR or 2.5Y, value of 2 or 3 (3 through 5, dry), and chroma of less than 2, moist or dry. It is typically silty clay loam, but textures of loam, silt loam, and clay loam are also in the range. Some pedons have an ACca horizon.

The Cca horizon has hue of 10YR, 2.5Y, or 5Y; value of 3 through 5; and chroma of 1 through 4. Some pedons do not have mottles in the lower part of the Cca horizon. The horizon contains 15 percent to more than 30 percent carbonates. The lower part of the C horizon has value of 4 through 6 and chroma of 2 to 4. Mottles range from few to many and from faint to prominent. Texture is silty clay loam or silt loam.

Some pedons have numerous pockets of gypsum crystals.

Borup series

The Borup series consists of deep, poorly drained, moderately rapidly permeable soils. These soils formed in a loamy mantle over sandy sediment. Borup soils are on lake plains. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Borup soils are commonly adjacent to Augsburg, Elmville, Glyndon, and Wheatville soils. They are similar to Arveson soils. Augsburg soils are on similar landscape positions. They have clayey material within 40 inches of the surface. Elmville, Glyndon, and Wheatville soils are somewhat poorly drained and moderately well drained and are on slightly higher positions. Arveson soils are very poorly drained and poorly drained and are coarse-loamy.

Typical pedon of Borup loam, 120 feet east and 2,200 feet south of the NW corner of sec. 33, T. 141 N., R. 46 W.:

Ap—0 to 9 inches; black (10YR 2/1) loam; very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; very friable; moderately alkaline; very strong effervescence; abrupt smooth boundary.

C1ca—9 to 18 inches; gray (5Y 5/1) very fine sandy loam; many fine distinct yellowish brown (10YR 5/8) mottles; weak very fine granular structure; very friable; moderately alkaline; violent effervescence.

C2—18 to 23 inches; grayish brown (2.5Y 5/2) loamy very fine sand; common fine distinct yellowish brown (10YR 5/8) mottles; massive; very friable; few fine prominent dark reddish brown (5YR 3/2) and black (5YR 2/1) concretions; moderately alkaline; moderate effervescence; clear smooth boundary.

C3—23 to 31 inches; light brownish gray (2.5Y 6/2) loamy very fine sand; common medium distinct olive yellow (2.5Y 6/6) and light yellowish brown (10YR 6/4) mottles; massive; very friable; common fine prominent dark reddish brown (5YR 3/2) concretions; moderately alkaline; moderate effervescence; clear smooth boundary.

C4—31 to 39 inches; gray (2.5Y 6/1) loamy very fine sand; many fine prominent yellowish brown (10YR 5/6 & 5/8) mottles; massive; very friable; common fine prominent dark reddish brown (5YR 3/2) concretions; moderately alkaline; moderate effervescence; clear smooth boundary.

C5—39 to 60 inches; light olive gray (5Y 6/2) very fine sandy loam; many large prominent yellowish brown (10YR 5/8) and strong brown (7.5YR 5/6 & 5/8) mottles; massive with some weakly defined layering and thin silt bands below 55 inches; very friable; common medium prominent dark reddish brown (5YR 3/3 & 3/4) concretions; moderately alkaline; strong effervescence.

Thickness of the mollic epipedon ranges from 7 to 20 inches. The A horizon has hue of 10YR, 2.5Y or 5Y, value of 2 or 3, and chroma of 1. In some pedons this horizon is neutral and has value of 2 or 3. Texture is very fine sandy loam, loam, silt loam, silty clay loam, or sandy clay loam. This horizon is mildly or moderately alkaline.

The Cca horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is loamy very fine sand, very fine sandy loam, loam, or silt loam. Some strata that have texture of sandy clay loam are also included. The underlying part of the C horizon has similar colors and few to many distinct or prominent mottles. It is dominantly loamy very fine sand and very fine sand, but layers of very fine sand loam are also present in some pedons. Reaction is mildly or moderately alkaline.

Cashel series

The Cashel series consists of deep, somewhat poorly drained, moderately slowly permeable and slowly permeable soils on flood plains. These soils formed in recent silty and clayey alluvium. Slopes range from 1 to 3 percent. These soils are occasionally flooded.

Cashel soils are commonly adjacent to Fargo and Wahpeton soils. Fargo soils are typically on broad flats that are less subject to flooding. Wahpeton soils are moderately well drained and are on high, terracelike positions that are less subject to flooding.

Typical pedon of Cashel silty clay, 450 feet north and 2,640 feet west of the SE corner of sec. 25, T. 141 N., R. 49 W.:

A11—0 to 8 inches; very dark gray (10YR 3/1) silty clay; gray (10YR 5/1) dry; moderate fine and medium angular blocky structure; friable; common roots; mildly alkaline; slight effervescence; gradual smooth boundary.

A12—8 to 17 inches; very dark grayish brown (2.5Y 3/2) silty clay; grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure; friable; common roots; mildly alkaline; slight effervescence; gradual smooth boundary.

C1—17 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay; finely stratified with silt loam; weak very fine subangular blocky structure; friable; common roots; mildly alkaline; slight to moderate effervescence; gradual smooth boundary.

C2—27 to 35 inches; very dark grayish brown (2.5Y 3/2) silty clay loam; moderate medium subangular blocky structure; friable; few partially decomposed woody fragments; common roots; mildly alkaline; moderate effervescence; gradual smooth boundary.

A1b—35 to 38 inches; black (10YR 2/1) silt loam; pockets of yellowish brown (10YR 5/6) and gray (5Y 6/1) marl-like sediment; weak very fine subangular blocky structure; very friable; few woody fragments; common roots; mildly alkaline; strong effervescence; clear wavy boundary.

C3—38 to 60 inches; dark olive gray (5Y 3/2) silty clay loam; few black (10YR 2/1) streaks; weak very fine subangular blocky structure; sticky; few shell fragments; few roots; mildly alkaline; slight effervescence.

Dark colored layers, fragments of woody materials, and snail shells are not present within a depth of 60 inches in some pedons.

The A horizon has hue of 10YR and 2.5Y, value of 2 or 3 (3 through 5 dry), and chroma of 1 or 2, moist or dry. Texture is silty clay loam, silty clay, or clay.

The C horizon has hue of 2.5Y or 5Y, value of 2 through 5, and chroma of 1 through 3, moist or dry.

Cathro series

The Cathro series consists of very poorly drained soils that have moderately rapid to moderately slow permeability. These soils formed in highly decomposed organic material over loamy mineral material. Cathro soils generally are in pocketed depressions or in closed swales and draws on uplands. Slopes are 0 to 2 percent. These soils are subject to ponding.

Cathro soils are commonly adjacent to Darnen, Flom, Quam, and Vallers soils. They are similar to and in places adjacent to Markey and Seelyeville soils. Darnen soils are moderately well drained and formed in mineral material on the edges of draws and at the base of slopes. Flom, Vallers, and Quam soils are poorly drained and formed in mineral materials. They typically are in shallow depressions, in swales, or on low flat areas in till plains and moraines. Markey soils have sandy material underlying the organic accumulations, and Seelyeville soils formed in thicker organic deposits.

Typical pedon of Cathro muck, 3,700 feet south and 1,056 feet east of the NW corner of sec. 31, T. 138 N., R. 44 W.:

Oa1—0 to 13 inches; black (10YR 2/1) and black (5YR 2/1) rubbed and pressed sapric material; about 1 percent fiber rubbed; weak very fine granular structure; very friable; nonsticky; herbaceous fiber; many roots; neutral; clear smooth boundary.

Oa2—13 to 21 inches; black (10YR 2/1) and black (5YR 2/1) rubbed and pressed sapric material; about 2 percent fiber rubbed; weak very fine granular structure; very friable; nonsticky; herbaceous fiber; neutral; abrupt smooth boundary.

IIC1g—21 to 40 inches; dark gray (5Y 4/1) silty clay loam; weak very fine subangular blocky structure; very friable; sticky; mildly alkaline; violent effervescence; clear smooth boundary.

IIC2g—40 to 60 inches; gray (5Y 5/1) clay loam; weak very fine subangular blocky structure; very friable; sticky; mildly alkaline; violent effervescence.

Depth to the loamy IIC horizon ranges from 16 to 50 inches. Fibers are dominantly herbaceous, but some thin layers of dominantly woody fiber are in some pedons.

The organic part of the control section has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2. Surface layers are muck or mucky peat. Hemic material less than 10 inches thick is in some pedons.

The IIC horizon has hue of 2.5Y, 10YR, or 5Y, value of 4 through 6, and chroma of 1 or 2. Texture is sandy loam, silt loam, clay loam, or silty clay loam. Reaction is neutral to moderately alkaline.

Colvin series

The Colvin series consists of deep, poorly drained, moderately slowly permeable and moderately permeable soils. These soils formed in silty lacustrine sediment on lake plains. Slopes are less than 2 percent. These soils are subject to rare flooding.

Colvin soils are commonly adjacent to Augsburg, Bearden, Borup, Fargo, and Wheatville soils. They are similar to Vallers soils. Augsburg soils formed in silty lacustrine and underlying loamy and clayey material and are on similar positions on the landscape. Bearden soils are somewhat poorly drained and are on slightly higher, typically convex parts of the landscape. Fargo soils are less calcareous in the upper sediment and are on similar landscape positions. Wheatville soils are somewhat poorly drained and moderately well drained and are on slightly higher, typically convex parts of the landscape. Vallers soils are fine-loamy.

Typical pedon of Colvin silty clay loam, 114 feet north and 1,580 feet west of the SE corner of sec. 31, T. 142 N., R. 46 W.:

Ap—0 to 11 inches; black (10YR 2/1) silty clay loam; very dark gray (5Y 3/1) dry; few light gray (5Y 7/2) lime streaks; weak fine subangular blocky structure; friable; slightly sticky; few roots; mildly alkaline; strong effervescence; abrupt smooth boundary.

C1ca—11 to 18 inches; gray (2.5Y 5/1) silt loam; weak fine subangular blocky structure; very friable; few roots; moderately alkaline; violent effervescence; clear smooth boundary.

C2ca—18 to 23 inches; gray (2.5Y 6/1) silty clay loam; common fine prominent yellowish brown (10YR 5/8) mottles; few fine black (N 2/0) concretions; weak fine subangular blocky structure; very friable; slightly sticky; few roots; moderately alkaline; violent effervescence; clear wavy boundary.

C3—23 to 40 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/8) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; slightly sticky; mildly alkaline; strong effervescence; gradual wavy boundary.

C4—40 to 60 inches; grayish brown (2.5Y 5/2) layered silty clay and thin silt loam bands; laminated with many medium and large prominent yellowish brown (10YR 5/8) and strong brown (7.5YR 5/6) layers of silty clay loam, silt loam, or very fine sandy loam; sticky or slightly sticky; moderately alkaline; strong effervescence.

The mollic epipedon ranges in thickness from 7 to 24 inches. In some pedons, the lower part of the mollic epipedon is part of the calcic horizon. The A1 or Ap horizon is neutral, or it has hue of 10YR, 2.5Y, and 5Y, value of 2 or 3 (3 or 4, dry), and chroma of 1 or less, moist or dry. Texture is silt loam or silty clay loam. Some pedons have an Aca or ACca horizon.

The Cca horizon has a calcium carbonate content of 20 to 40 percent. It has hue of 2.5Y or 5Y, value of 3 through 6, and chroma of 0 to 2. The rest of the C horizon has hue of 2.5Y or 5Y, value of 3 through 6, and chroma of 1 through 3. It typically has few to many mottles that have chroma of 3 through 8.

Darnen series

The Darnen series consists of deep, moderately well drained, moderately permeable soils. These soils formed in loamy colluvial material on glacial till uplands. Slopes range from 1 to 3 percent.

Darnen soils are typically adjacent to Barnes, Flom, Gonvick, Kittson, and Waukon soils. Barnes and Waukon are on higher and typically more sloping or rolling positions. Flom soils are poorly drained and commonly are in lower swales and shallow depressions. Gonvick and Kittson soils have a thinner mollic epipedon and are typically on more convex areas.

Typical pedon of Darnen loam, 2,515 feet west and 525 feet south of the NE corner of sec. 23, T. 137 N., R. 45 W.:

A11—0 to 28 inches; black (10YR 2/1) loam; very dark grayish brown (10YR 3/2) dry; moderate to fine angular blocky structure parting to weak and moderate very fine subangular blocky; friable; many roots; neutral; gradual smooth boundary.

A12—18 to 25 inches; very dark brown (10YR 2/2) loam; very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure parting to weak very fine granular; very friable; many roots; slightly acid; gradual smooth boundary.

B1—25 to 37 inches; very dark grayish brown (10YR 3/2) loam; dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure parting to weak very fine granular; friable; few roots; slightly acid; gradual smooth boundary.
B2—37 to 48 inches; very dark grayish brown (10YR 3/2) loam; brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure parting to weak very fine granular; very friable; slightly acid; clear smooth boundary.
C1—48 to 60 inches; dark grayish brown (10YR 4/2) loam; many medium distinct multicolored mottles; moderate medium subangular blocky structure parting to moderate very fine subangular blocky; friable; firm; slightly acid.

Thickness of the solum ranges from 30 to 50 inches. The mollic epipedon ranges from 20 to 48 inches in thickness. Pedons are commonly free of coarse fragments, but some have up to 5 percent coarse fragments, mostly in the lower part. Some pedons have lenses of sand and loamy sand in the lower part.

The A horizon has value of 2 or 3 (2 through 4, dry) and chroma of 1 or 2. Texture is loam, silt loam, sandy loam, or clay loam.

The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 through 4. Texture is loam, silt loam, sandy loam, or clay loam. In some pedons, mottles are at a depth below 36 inches.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 6. Texture is loam or clay loam.

Dickey series

The Dickey series consists of deep, well drained soils. These soils formed dominantly in a sandy lacustrine or outwash mantle and underlying loamy till or lacustrine material on lake plains. They have rapid permeability in the upper sediment and moderately slow permeability in the underlying material. Slopes range from 1 to 3 percent.

Dickey soils are adjacent to Foldahl, Lohnes, and Maddock soils. They are similar to Swenoda soils. Foldahl soils are moderately well drained and typically are on a slightly lower position on the landscape. The well drained Lohnes coarse sandy loam soils are on slightly higher landscape positions and are commonly on ridges. The moderately well drained Lohnes sandy loam soils commonly are on slightly lower, concave positions. Maddock soils do not have contrasting loamy material within 40 inches of the surface and typically are on similar landscape positions. Swenoda soils are moderately well drained and have less sand in the upper sediment.

Typical pedon of Dickey loamy fine sand, 2,600 feet west and 255 feet south of the NE corner of sec. 31, T. 142 N., R. 44 W.:

A1—0 to 10 inches; very dark gray (10YR 3/1) loamy fine sand; very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; very friable; many fine roots; slightly acid; clear wavy boundary.
B2—10 to 16 inches; dark grayish brown (10YR 4/2) loamy fine sand; weak fine subangular blocky structure; very friable; common roots; slightly acid; clear wavy boundary.
B31—16 to 26 inches; yellowish brown (10YR 5/4) fine sand; single grain; slightly firm in places; common roots; neutral; clear wavy boundary.
IIB32—26 to 31 inches; yellowish brown (10YR 5/6) fine sandy loam; weak very fine granular structure; very friable; few roots; neutral; gradual wavy boundary.
IIC—31 to 60 inches; light brownish gray (2.5Y 6/3) loam; common medium distinct olive yellow (2.5Y 6/6 & 6/8) mottles; weak medium subangular blocky structure; friable; 5 percent coarse fragments; moderately alkaline; moderate effervescence.

Depth to the IIC horizon ranges from 20 to 40 inches. The mollic epipedon is less than 16 inches thick.

The A horizon has value of 2 or 3 (3 or 4, dry) and chroma of 1 or 2, moist or dry. It is typically loamy fine sand or loamy sand, but thin A horizons of sandy loam or fine sandy loam are in some pedons.

The B2 horizon has hue of 10YR or 2.5Y, value of 2 through 5, and chroma of 1 through 4, moist or dry. Texture of the B2 horizon is loamy fine sand or loamy sand. Some pedons do not have a IIB3 horizon.

The IIC horizon has hue of 2.5Y or 5Y, value of 4 through 6 (5 through 8, dry), and chroma of 2 through 4, moist or dry. It is typically loam or clay loam, but silt loam is within the range. A thin stone or gravel line occurs near the upper boundary of the IIC horizon in some pedons.

Divide series

The Divide series consists of deep, somewhat poorly drained and moderately well drained soils. These soils formed in a mantle of loamy water-worked glacial till over sandy and gravelly material. A loamy substratum is within 60 inches of the surface. Permeability is moderate. These soils are on lake-washed glacial till plains uplands. Slopes commonly range from 0 to 2 percent.

Divide soils are commonly adjacent to Grimstad, Hamerly, Kittson, and Vallers soils. Grimstad soils typically are on similar positions, most often on outwash and shore line associated landscapes. Hamerly and Kittson soils are on similar or slightly more sloping positions, typically on eroded till landscapes. Vallers soils are poorly drained and are on lower, typically concave parts of eroded till plains.

Typical pedon of Divide loam, loamy substratum, 435 feet south and 792 feet east of the NW corner of sec. 16, T. 142 N., R. 44 W.:

A1—0 to 13 inches; black (10YR 2/1) loam; dark gray (10YR 4/1) dry; weak fine angular blocky structure parting to weak fine granular; slightly hard; 1 percent coarse fragments; mildly alkaline; strong effervescence; abrupt wavy boundary.

C1ca—13 to 21 inches; dark gray (10YR 4/1) loam; weak fine granular structure; soft; 2 percent coarse fragments; mildly alkaline; violent effervescence; abrupt smooth boundary.

IIC2—21 to 27 inches; light brownish gray (2.5Y 6/2) gravelly sand; common medium distinct yellowish brown (10YR 5/6 & 5/8) mottles; massive; loose; moderately alkaline; strong effervescence; abrupt wavy boundary.

IIC3—27 to 36 inches; light brownish gray (2.5Y 6/2) sand; common fine faint light olive gray (5Y 6/2) mottles; single grain; loose; 4 percent coarse fragments; moderately alkaline; slight effervescence; clear smooth boundary.

IIC4—36 to 44 inches; light brownish gray (2.5Y 6/2) gravelly sand; many coarse prominent dark brown (7.5YR 3/4) and yellowish brown (10YR 5/6 & 5/8) mottles; massive; loose; 16 percent coarse fragments; moderately alkaline; slight effervescence; abrupt smooth boundary.

IIIC5—44 to 60 inches; olive gray (5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/6 & 5/8) mottles; strong fine angular blocky structure; friable; 5 percent coarse fragments; mildly alkaline; strong effervescence.

Depth to sand and gravel ranges from 20 to 36 inches. The mollic epipedon ranges from 7 to 16 inches in thickness. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 through 5, dry), and chroma of 1, moist or dry. It is loam, sandy loam, silt loam, or light clay loam. Some pedons have an Aca horizon.

The Cca horizon has hue of 10YR or 2.5Y, value of 3 through 6, and chroma of 1 through 4. It is loam or clay loam.

The IIC horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 through 7, and chroma of 2 through 6. It is mixed sand and gravel, some of which may be stratified.

The IIIC horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. Texture is loam, fine sandy loam, silt loam, or clay loam.

Donaldson series

The Donaldson series consists of deep, somewhat poorly drained, and moderately well drained soils. These soils formed in loamy lacustrine sediment over clayey lacustrine sediment or clayey till on lake plains. They have moderately rapid permeability in the upper sediment and slow permeability in the contrasting lower sediment. Slopes range from 0 to 2 percent.

Donaldson soils are commonly adjacent to Bearden, Foldahl, Overly, and Viking soils. They are similar to Elmville soils. Bearden and Elmville soils are on similar landscape positions and are strongly calcareous at or near the surface. Foldahl soils are commonly on similar landscape positions and have thicker, sandy upper sediment. Overly soils are also on similar landscape positions and formed in silty clay loam. Viking soils are poorly drained and typically are on slightly lower, plane or slightly concave positions.

Typical pedon of Donaldson fine sandy loam, 650 feet west and 1,585 feet north of the SE corner of sec. 19, T. 139 N., R. 47 W.:

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam; very dark gray (10YR 3/1) dry; weak very fine granular structure; firm to friable; mildly alkaline; abrupt smooth boundary.

B1—9 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam; dark gray (10YR 4/1) dry; few bleached fine sand grains; cloddy parting to weak very fine platy structure; firm; mildly alkaline; gradual smooth boundary.

B2—15 to 20 inches; dark brown (10YR 4/3) fine sandy loam; few bleached sand grains and faint discoloration along fine roots; cloddy parting to weak very fine granular structure; very friable; mildly alkaline; gradual smooth boundary.

C1—20 to 26 inches; brown (10YR 5/3) fine sandy loam; common fine prominent yellowish brown (10YR 5/6 & 5/8) mottles; weak very fine granular structure; very friable; few fine prominent dusky red (2.5YR 3/2) concretions; slightly cemented in place; mildly alkaline; slight effervescence; clear smooth boundary.

C2—26 to 32 inches; light brownish gray (2.5Y 6/3) very fine sandy loam; common fine and medium distinct light olive brown (2.5Y 5/6), olive yellow (2.5Y 6/6), and brownish yellow (10YR 6/6) mottles; single grain; very friable to loose; few fine prominent dusky red (2.5YR 3/2) concretions; mildly alkaline; slight effervescence; abrupt smooth boundary.

IIC3—32 to 60 inches; dark gray (5Y 4/1) clay; common medium prominent light gray (5Y 7/1) lime masses; moderate fine and medium angular blocky structure; sticky; moderately alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 10 to 20 inches. Thickness of the coarse loamy sediment over clayey material is 20 to 40 inches. The mollic epipedon is 8 to 16 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam, very fine sandy loam, sandy clay loam, or loam. The A horizon is neutral or mildly alkaline.

The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. Some pedons have few or common and faint through prominent mottles in this horizon. Texture is loamy very fine sand, fine sandy loam, very fine sandy loam, or loam. Reaction is neutral or mildly alkaline.

The C horizon above the IIC has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It has faint, distinct, or prominent mottles. Texture is very fine sand, loamy very fine sand, very fine sandy loam, or fine sandy loam. Reaction is mildly or moderately alkaline.

The IIC horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It has few, common, or many mottles or light colored lime masses. Texture is typically clay or silty clay, but silty clay loam and clay loam are in the range. Reaction is mildly or moderately alkaline.

Elmville series

The Elmville series consists of deep, somewhat poorly drained and moderately well drained soils. These soils dominantly formed in sandy and loamy sediment over clayey sediment on lake plains. They have moderately rapid permeability in the upper sediments and slow permeability in the underlying material. Slopes range from 0 to 3 percent.

Elmville soils are commonly adjacent to Glyndon, Wheatville, and Wyndmere soils. They are similar to Grimstad soils. Glyndon and Wyndmere soils are on similar landscape positions and do not have contrasting clayey material within 40 inches of the surface. Grimstad soils have more sand in the upper sediment that is overlying a loamy IIC horizon. Wheatville soils have less sand and more silt in the upper sediment. Grimstad and Wheatville soils are on similar landscape positions.

Typical pedon of Elmville fine sandy loam, 1,060 feet west and 100 feet south of the NE corner of sec. 17, T. 137 N., R. 46 W.:

Ap—0 to 11 inches; black (10YR 2/1) fine sandy loam; very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; very friable; mildly alkaline; slight effervescence; abrupt smooth boundary.

A12ca—11 to 14 inches; very dark gray (10YR 3/1) very fine sandy loam; dark gray (10YR 4/1) dry; weak very fine granular structure; very friable; moderately alkaline; slight effervescence; clear smooth boundary.

C1ca—14 to 21 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak very fine granular structure; very friable; moderately alkaline; strong effervescence; clear smooth boundary.

C2ca—21 to 26 inches; grayish brown (10YR 5/2) very fine sandy loam; few fine distinct light olive brown (2.5Y 5/6), olive yellow (2.5Y 6/6), and light yellowish brown (2.5Y 6/4) mottles; weak medium platy structure; very friable; strongly alkaline; violent effervescence; clear smooth boundary.

C3—26 to 30 inches; light yellowish brown (2.5Y 6/4) loamy fine sand; common fine and medium distinct light olive brown (2.5Y 5/6), olive yellow (2.5Y 6/6), and yellowish brown (10YR 5/6) mottles; single grain; loose; few fine prominent very dusky red (2.5YR 2/2) iron concretions; strongly alkaline; slight effervescence; clear wavy boundary.

IIC4—30 to 60 inches; stratified very dark gray (5Y 3/1) and dark olive gray (5Y 3/2) clay; few fine prominent light olive brown (2.5Y 5/6) and olive yellow (2.5Y 6/6) mottles; strong very fine angular blocky structure; sticky; few light gray (2.5Y 7/1) sand coatings on vertical fractures; few limy masses; moderately alkaline; strong effervescence.

The mollic epipedon ranges from 7 to 16 inches in thickness. The calcic horizon begins within 16 inches of the surface. The upper sediments are 20 to 40 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 through 5, dry), and chroma of 1 or 2, moist or dry. Texture is fine sandy loam, loamy very fine sand, very fine sandy loam, loamy fine sand, or sandy loam. Reaction is mildly or moderately alkaline.

The Cca horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 or 3. Texture is loamy fine sand, very fine sandy loam, loamy very fine sand, or fine sandy loam. Reaction is moderately or strongly alkaline.

The rest of the C horizon above the IIC has hue of 10YR through 5Y, value of 4 through 6, and chroma of 2 through 4. Mottles are in some or all parts. Texture is fine sandy loam, very fine sandy loam, loamy very fine sand, loamy fine sand, very fine sand, or fine sand. Reaction is mildly through strongly alkaline.

The IIC horizon has hue of 2.5Y or 5Y, value of 3 through 6, and chroma of 1 through 3. Texture is silty clay loam, silty clay, or clay. Reaction is mildly or moderately alkaline.

Fargo series

The Fargo series consists of deep, poorly drained, slowly permeable soils. These soils formed in lacustrine material on broad flats and in shallow swales and depressions on the glacial lake plain. Slopes range from 0 through 6 percent. These soils are subject to rare flooding.

Fargo soils are commonly adjacent to Bearden, Cashel, Colvin, Hegne, and Wahpeton soils. They are similar to Northcote soils. Bearden soils are better drained and are on slightly higher positions on the landscape. Cashel soils are on flood plains. Colvin soils are more calcareous at or near the surface and are on landscape positions similar to those of Fargo soils. Hegne soils typically are on slight rises or ridges and are mapped in complex with Fargo soils. Wahpeton soils are somewhat poorly drained and typically are on high terrace positions near major stream channels. Northcote soils are in the very fine family.

Typical pedon of Fargo silty clay, 0 to 2 percent slopes, 600 feet west and 800 feet north of the SE corner of sec. 19, T. 141 N., R. 48 W.:

Ap—0 to 7 inches; black (10YR 2/1) silty clay; very dark gray (10YR 3/1) dry; weak fine granular structure; friable; very sticky; common roots; neutral; abrupt smooth boundary.

A12—7 to 12 inches; black (10YR 2/1) silty clay; very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; firm; very sticky; common roots; neutral; clear irregular boundary broken by tongues of Ap and A1 material extending to 36 inches.

B1g—12 to 24 inches; very dark gray (5Y 3/1) silty clay; olive gray (5Y 5/2) dry; weak fine angular blocky structure parting to weak very fine subangular blocky; firm; very sticky; common roots; slight effervescence; mildly alkaline; gradual smooth boundary.

C1gca—24 to 39 inches; olive gray (5Y 5/2) silty clay; lower 8 inches has common fine distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; weak fine angular blocky structure; firm; very sticky; few roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C2g—39 to 60 inches; olive gray (5Y 5/2) silty clay; common medium distinct olive yellow (2.5Y 6/6 & 6/8) and brownish yellow (10YR 6/6) mottles; some lamination parting to weak fine angular blocky structure; firm; very sticky; slight effervescence; moderately alkaline.

Solum thickness ranges from 16 to 36 inches. The mollic epipedon ranges from 8 to 24 inches in thickness. Depth to free carbonates ranges from 11 to 25 inches.

The A horizon is neutral or has hue of 10YR, 2.5Y, or 5Y, value of 1 or 2 (3 or 4, dry), and chroma of 1, moist or dry. Texture is silty clay loam, silty clay, or clay.

The B horizon has hue of 2.5Y and 5Y, value of 2 through 4 (3 through 5, dry), and chroma of 1 or 2, moist or dry. In some pedons, the lower part of the Bg horizon is mottled.

The Cgca horizon has hue of 2.5Y or 5Y, value of 4 through 6 (5 through 7, dry), and chroma of 1 or 2, moist or dry. It contains 10 to 25 percent calcium carbonate equivalent.

The rest of the Cg horizon has hue of 2.5Y or 5Y, value of 4 through 6 (5 through 8, dry), and chroma of 1 through 3, moist or dry. It typically has common to many distinct or prominent mottles. Laminated silty clay, clay, silty clay loam, and silt loam sediments may occur at a depth of 36 to 60 inches.

Flaming series

The Flaming series consists of deep, moderately well drained and somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on lake plains and in areas of sandy outwash. Slopes range from 0 to 3 percent.

Flaming soils commonly are adjacent to Arveson, Fossum, Poppleton, and Ulen soils. They are similar to and, in places, adjacent to Maddock soils. Arveson and Fossum soils are more poorly drained and are on lower, depressional positions. Poppleton soils are on similar landscapes and have a thinner dark colored surface layer. They are calcareous at or near the surface. Maddock soils are well drained and are on higher, more sloping landscape positions.

Typical pedon of Flaming fine sand, 180 feet south and 2,110 feet east of the NW corner of sec. 22, T. 138 N, R. 45 W.:

A1—0 to 13 inches; very dark brown (10YR 2/2) fine sand; very dark gray (10YR 3/1) dry; many gray (10YR 5/1) sand grains; weak medium subangular blocky structure parting to weak very fine granular; very friable; many roots; neutral; clear smooth boundary.

B1—13 to 20 inches; very dark grayish brown (10YR 3/2) fine sand; dark grayish brown (10YR 4/2) dry; single grain; very friable to loose; many roots; neutral; clear smooth boundary.

B2—20 to 27 inches; dark brown (10YR 4/3) fine sand; few fine faint dark yellowish brown (10 YR 3/4) mottles; single grain; loose; some roots; neutral; clear smooth boundary.

B3—27 to 35 inches; brown (10YR 5/3) fine sand; many fine and medium distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 3/5) mottles; single grain; loose; mildly alkaline; gradual smooth boundary.

C1—35 to 60 inches; light brownish gray (2.5Y 6/2) fine sand; few medium to distinct light olive brown (2.5Y 5/6) and brownish yellow (10YR 6/6) mottles; single grain; slight effervescence; loose; mildly alkaline.

Solum thickness ranges from 20 to 40 inches. Depth to free carbonates is typically 40 to 60 inches but is 20 inches in some pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 through 5, dry), and chroma of 1 or 2, moist or dry. The A horizon is fine sand or loamy fine sand.

The B horizon has hue of 10YR in the upper part and hue of 10YR or 2.5Y in the lower part, value of 3 through 5 (5 or 6, dry), and chroma of 2 through 4, moist or dry. Texture in this horizon is fine sand or loamy fine sand.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (6 or 7, dry), and chroma of 1 through 3. It is typically fine sand but is sand in the lower part in some pedons. Reaction ranges from medium acid to moderately alkaline.

Flom series

The Flom series consists of deep, poorly drained and very poorly drained soils that have moderately slow permeability. These soils formed in loamy glacial till on uplands. Slopes range from 0 to 2 percent.

Flom soils are commonly adjacent to Barnes, Darnen, Gonvick, Kittson, and Quam soils. Barnes and Gonvick soils are better drained and are on higher, typically more sloping or rolling positions. Darnen soils are moderately well drained and commonly are at the base of steeper slopes. Kittson soils are somewhat poorly drained and moderately well drained and are on slightly higher landscape positions. Quam soils are very poorly drained and are in partly filled depressions.

Typical pedon of Flom clay loam, 105 feet east and 2,084 feet south of the NW corner of sec. 22, T. 140 N., R 44 W.:

Ap—0 to 9 inches; black (10YR 2/1) clay loam; very dark gray (10YR 3/1) dry; moderate fine angular blocky structure parting to weak very fine granular structure; friable; about 1 percent coarse fragments; mildly alkaline; no effervescence; clear smooth boundary.

A12—9 to 14 inches; very dark gray (10YR 3/1) clay loam; dark gray (10YR 4/1) dry; moderate fine angular blocky structure; friable; about 1 percent coarse fragments; mildly alkaline; gradual smooth boundary.

B2g—14 to 23 inches; dark gray (5Y 4/1) silty clay loam; moderate to strong fine angular blocky structure; sticky; about 1 percent coarse fragments; mildly alkaline; gradual wavy boundary.

C1—23 to 29 inches; olive gray (5Y 5/2) loam; few fine prominent multicolored mottles; medium very fine angular blocky structure; friable; about 5 percent coarse fragments; mildly alkaline; slight effervescence; gradual smooth boundary.

C2ca—29 to 35 inches; light olive gray (5Y 6/2) loam; common fine prominent yellowish brown (10YR 5/8) and common medium distinct light yellowish brown (2.5Y 6/4) mottles; moderate fine angular blocky structure; friable; about 4 percent coarse fragments; moderately alkaline; strong effervescence; clear smooth boundary.

C3—35 to 60 inches; olive gray (5Y 5/2) loam; common fine prominent yellowish brown (10YR 5/8) and common medium distinct pale olive (5Y 6/4) mottles; moderate fine angular blocky structure; friable; moderately alkaline; strong effervescence.

The thickness of the solum and depth to free carbonates range from 14 to 48 inches. The mollic epipedon ranges from 10 to 24 inches in thickness. The solum has 1 to 10 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is neutral and has value of 2 or 3. Mottles are in the lower part of this horizon in some pedons. Texture of the A horizon is silty clay loam or clay loam. Reaction is neutral or mildly alkaline.

The B horizon has hue of 2.5Y or 5Y, value of 3 through 5 (4 through 6, dry), and chroma of 1 or 2. It is mottled in some pedons. Texture of the B horizon is silty clay loam, clay loam, or loam.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 or 3. It commonly has mottles in all parts. Its texture is loam or clay loam, and in some pedons, it grades to fine sandy loam below a depth of 36 inches. Reaction is mildly or moderately alkaline. Calcium carbonate content ranges from 10 to 30 percent.

Foldahl series

The Foldahl series consists of deep, moderately well drained soils. These soils formed in a sandy mantle over loamy material in lake basins or on eroded till plains or uplands associated with outwash deposits. They have rapid permeability in the upper sediment and moderately slow or moderate permeability in the lower sediment. Slopes range from 0 to 3 percent.

Foldahl soils are commonly adjacent to Flaming, Grimstad, Rockwell, and Swenoda soils. They are similar to Foxhome soils. Flaming soils do not have contrasting loamy material within 40 inches of the surface, are on similar landscape positions, and are calcareous at or near the surface. Rockwell soils are poorly drained and are on lower flats and in swales. Swenoda soils have a finer textured mantle and are on similar positions on the landscape. Foxhome soils typically have a finer textured surface layer and a layer of gravel and coarse sand above the contrasting loamy material. They are on similar positions on the landscape.

Typical pedon of Foldahl loamy fine sand, 385 feet east and 1,290 feet south of the NW corner of sec. 26, T. 142 N., R. 45 W.:

Ap—0 to 11 inches; black (10YR 2/1) loamy fine sand; very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to weak very fine granular; very friable; common fine bleached sand grains; neutral; abrupt smooth boundary.

B2—11 to 16 inches; very dark grayish brown (10YR 3/2) loamy fine sand; grayish brown (10YR 5/2) dry; weak very fine granular structure; very friable; few fine bleached sand grains; neutral; clear wavy boundary.

B3—16 to 22 inches; dark brown (10YR 4/3) fine sand; few fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8) mottles; weak very fine granular structure; very friable; neutral; clear wavy boundary.

C1—22 to 29 inches; brown (10YR 5/3) loamy fine sand; many fine distinct yellowish brown (10YR 5/8) and dark yellowish brown (10YR 4/4) mottles; single grain; loose; clear smooth boundary.

IIC2—29 to 37 inches; light brownish gray (2.5Y 6/2) loam; many fine and medium prominent yellowish brown (10YR 5/6 & 5/8) mottles; weak very fine subangular blocky structure; slightly sticky; very friable; mildly alkaline; moderate effervescence; gradual smooth boundary.

IIC3—37 to 60 inches; light gray (2.5Y 7/2) loam; many medium and large prominent yellowish brown (10 YR 5/6 & 5/8) mottles and few fine prominent dark reddish brown (5YR 3/4) and yellowish red (5YR 5/8) mottles; weak fine platy structure; slightly sticky; very friable; mildly alkaline; moderate effervescence.

Thickness of the solum and depth to free carbonates range from 16 to 32 inches. The mollic epipedon ranges in thickness from 7 to 16 inches. Thickness of the sandy sediment over contrasting loamy material ranges from 20 to 40 inches. The upper sediment typically does not have coarse fragments in the upper part, but in some pedons the upper part is as much as 5 percent coarse fragments. A lag line up to 6 inches thick with up to 35 percent of coarse fragments may be present at the contact of the two sediments.

The A horizon has value of 2 or 3 (2 through 4, dry) and chroma of 1 or 2. Texture is loamy sand and loamy fine sand. Reaction ranges from slightly acid through mildly alkaline.

The B horizon has value of 3 or 4 (4 through 6, dry) and chroma of 2 through 4. It is sand, fine sand, loamy sand, or loamy fine sand. Its reaction is neutral or mildly alkaline.

Some pedons have a Cca horizon that has hue of 10YR or 2.5Y, value of 5 or 6 (5 through 7, dry), and chroma of 2 through 4. The range in texture is the same as that of the B horizon.

The IIC horizon has hue of 10YR or 2.5Y, value of 5 through 7 (5 through 8, dry), and chroma of 2 through 4. It has few to many mottles. Texture is sandy loam, fine sandy loam, loam, silt loam, clay loam, or silty clay loam. Reaction is mildly or moderately alkaline.

Fossum series

The Fossum series consists of deep, poorly drained, rapidly permeable soils. These soils formed in calcareous sandy deposits in lake basins. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Fossum soils are commonly adjacent to Arveson, Flaming, Poppleton, Rockwell, and Ulen soils. Arveson soils typically are on similar positions on the landscape. They are more strongly calcareous at or near the surface. Flaming, Poppleton, and Ulen soils are better drained and typically are on higher, slightly convex positions. Rockwell soils typically are on similar landscape positions and have contrasting loamy material within 40 inches of the surface.

Typical pedon of Fossum loamy sand, 300 feet west and 150 feet north of the SE corner of sec. 16, T. 138 N., R. 46 W.:

A1—0 to 10 inches; black (10YR 2/1) loamy sand; very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; many roots; mildly alkaline; moderate effervescence; clear wavy boundary.

C1ca—10 to 18 inches; dark gray (2.5Y 4/1) loamy fine sand; gray (2.5Y 5/1) dry; weak very fine granular structure; very friable; grades with depth to massive; loose; many roots; moderately alkaline; strong effervescence; clear wavy boundary.

C2—18 to 35 inches; light brownish gray (2.5Y 6/2) fine sand; common medium distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; single grain; loose; many roots; moderately alkaline; medium effervescence; abrupt smooth boundary.

C3—35 to 47 inches; olive gray (5Y 5/2) mixed with olive (5Y 5/3) fine sand; common medium distinct brownish yellow (10YR 6/6) and olive yellow (2.5Y 6/6) mottles; single grain; loose; moderately alkaline; slight effervescence; clear wavy boundary.

C4—47 to 60 inches; pale olive (5Y 6/3) fine sand; many medium prominent yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles, and common medium distinct olive yellow (2.5Y 6/6) mottles; single grain; loose; moderately alkaline; slight effervescence.

The mollic epipedon ranges from 10 to 24 inches in thickness. The profile typically does not have coarse fragments, but a few pedons contain as much as 5 percent coarse fragments in the lower part of the C horizon.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2, or it is neutral and has value of 2 or 3. Some pedons have mottles in this horizon. Texture is dominantly loamy sand, but the range includes fine sand, sand, loamy fine sand, sandy loam, or fine sandy loam. Reaction is mildly or moderately alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 through 3. It has few to many mottles. Texture is typically fine sand or sand but ranges to loamy sand, loamy fine sand, sandy loam, or fine sandy loam in the upper part in some pedons.

Reaction in the C horizon is mildly or moderately alkaline.

Foxhome series

The Foxhome series consists of deep, moderately well drained, moderately permeable soils. These soils formed in loamy and sandy upper sediment over sandy and gravelly layers underlain by loamy glacial deposits on lake-washed till plains. They are on lake plains. Slopes range from 0 to 3 percent.

Foxhome soils are commonly adjacent to Foldahl soils, Kittson fine sandy loam, and Lohnes soils. They are similar to Swenoda soils. Foldahl soils formed in a sandy upper mantle and are on similar landscape positions. Kittson fine sandy loam formed in water-worked loamy glacial till and is on similar landscape positions. Lohnes soils do not have contrasting loamy material within 40 inches of the surface and are on similar landscape positions, except for the well drained phase of Lohnes soils, which is typically on higher, more convex ridgelike areas. Swenoda soils typically have a sandy loam upper mantle that has few or no coarse fragments. They typically are on similar landscape positions.

Typical pedon of Foxhome fine sandy loam, 180 feet east and 2,630 feet north of the SW corner of sec. 7, T. 138 N., R. 45 W.:

A1—0 to 10 inches; black (10YR 2/1) fine sandy loam; very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; few boulders on surface; few fine bleached sand grains; common roots; mildly alkaline; gradual smooth boundary.

B2—10 to 14 inches; very dark grayish brown (10YR 3/2) loamy sand; dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; common roots; mildly alkaline; clear wavy boundary.

B3—14 to 18 inches; grayish brown (10YR 5/2) loamy sand; single grain; loose; about 10 percent coarse fragments; common roots; mildly alkaline; clear smooth boundary.

IIC1—18 to 27 inches; grayish brown (2.5Y 5/2) very gravelly loamy coarse sand; few large distinct yellowish brown (10YR 5/8) mottles in bottom 3 inches; single grain; loose; about 55 percent coarse fragments; common roots; moderate effervescence; moderately alkaline; abrupt smooth boundary.

IIIC2ca—27 to 34 inches; light brownish gray (2.5Y 6/2) fine sandy loam; common fine distinct olive yellow (2.5Y 6/6) and yellow (2.5Y 7/6) and few fine prominent yellowish brown (10YR 5/8) mottles; weak very fine subangular blocky structure; very friable; about 7 percent coarse fragments; few roots; violent effervescence; moderately alkaline; gradual smooth boundary.

IIIC3—34 to 60 inches; light brownish gray (2.5Y 6/2) fine sandy loam; many medium prominent yellowish brown (10YR 5/6 & 5/8) and dark reddish brown (5YR 3/2) mottles; weak very fine subangular blocky structure; very friable; common fine prominent very dusky red (2.5Y 2.5/2) concretions; about 7 percent coarse fragments; few roots to 42 inches; strong effervescence.

The thickness of the solum and the depth to free carbonates range from 15 to 30 inches. The mollic epipedon ranges from 10 to 16 inches in thickness. The solum is neutral or mildly alkaline. The solum contains less than 15 percent coarse fragments. The IIC horizon averages 35 to 75 percent coarse fragments.

The A horizon has value of 2 or 3 (3 or 4, dry) and chroma of 1 or 2. The texture is sandy loam, fine sandy loam, loam, or silt loam.

The B horizon has value of 3 through 5 and chroma of 2 or 3. Texture is loamy sand, sandy loam, loam, and gravelly loamy sand or gravelly sand in the lower part of the B horizon in some pedons.

The IIC horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. Reaction is mildly or moderately alkaline.

The IIIC horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 or 3. Texture is sandy loam, fine sandy loam, loam, clay loam, silt loam, or silty clay loam. Reaction is mildly to moderately alkaline.

Glyndon series

The Glyndon series consists of deep, somewhat poorly drained, and moderately well drained, moderately permeable soils. These soils formed in loamy and sandy lacustrine material on lake plains. Slopes range from 0 to 6 percent.

Glyndon soils are commonly adjacent to Augsburg, Borup, and Wheatville soils. They are similar to and, in places, adjacent to Wyndmere soils. Augsburg and Borup soils are poorly drained and typically are on slightly lower positions on the landscape. Wheatville soils are on similar landscape positions and have contrasting clayey material within 40 inches of the surface. Wyndmere soils are coarse-loamy. They are on similar landscapes but do not commonly occur on slopes over 2 percent.

Typical pedon of Glyndon loam, 0 to 2 percent slopes, 115 feet north and 110 feet east of the SW corner of sec. 25, T. 140 N., R. 47 W.:

A1—0 to 10 inches; black (10YR 2/1) loam; dark gray (10YR 4/1) dry; weak medium granular structure; very friable; moderately alkaline; strong effervescence; clear smooth boundary.

A1ca—10 to 13 inches; very dark grayish brown (10YR 3/2) loam; gray (10YR 5/1) dry; few light brownish gray (10YR 6/2) lime streaks; weak medium subangular blocky structure; very friable; violent effervescence; strongly alkaline; clear irregular boundary.
C1ca—13 to 22 inches; grayish brown (10YR 5/2) loam; weak very fine subangular blocky structure; very friable; violent effervescence; strongly alkaline; clear wavy boundary.
C2—22 to 31 inches; light yellowish brown (2.5Y 6/4) very fine sandy loam; few fine distinct yellowish brown (10YR 5/6 & 5/8) mottles; massive; very friable; strong effervescence; strongly alkaline; gradual smooth boundary.
C3—31 to 40 inches; light yellowish brown (2.5Y 6/4) loamy very fine sand; many medium distinct yellowish brown (10YR 5/6 & 5/8) mottles; massive; very friable; few fine prominent dark reddish brown (5YR 3/2) concretions; moderate effervescence; moderately alkaline; gradual smooth boundary.
C4—40 to 60 inches; light brownish gray (2.5Y 6/2) very fine sand; many large prominent yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; single grain; very friable; common fine prominent dark reddish brown (5YR 2/2 & 3/3) concretions; moderately strong effervescence; moderately alkaline.

Thickness of the mollic epipedon ranges from 7 to 16 inches. The calcic horizon is within 16 inches of the surface.

The A horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1 or 2, moist or dry. Texture is very fine sandy loam, loam, silt loam, sandy clay loam, or silty clay loam. Reaction is mildly or moderately alkaline. Some pedons do not have an A1ca horizon.

The Cca horizon has value of 4 through 6 and chroma of 2 or 3. Mottles are in this horizon in some pedons. Texture is loam, silt loam, sandy clay loam, loamy very fine sand, or very fine sandy loam. Reaction is moderately or strongly alkaline. The rest of the C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 3 or 4 in the upper part and 2 through 4 in the lower part. Texture is typically very fine sand, loamy very fine sand, or very fine sandy loam.

Gonvick series

The Gonvick series consists of deep, moderately well drained, moderately permeable soils. These soils formed in loamy glacial till on uplands. Slopes range from 1 to 4 percent.

Gonvick soils are commonly adjacent to Flom, Quam, and Waukon soils. They are similar to Kittson loam soils. Flom and Quam soils are poorly drained and very poorly drained and are in swales and depressions. Waukon soils are well drained and are on higher and commonly more rolling and hilly parts of the landscape. Kittson soils are on similar landscapes positions and formed in calcareous loamy glacial till. They differ by having a less developed B horizon.

Typical pedon of Gonvick clay loam, 1 to 4 percent slopes, 2,466 feet west and 2,670 feet north of the SE corner of sec. 24, T. 139 N., R. 44 W.:

A1—0 to 11 inches; black (10YR 2/1) clay loam; very dark gray (10YR 3/1) dry; moderate medium angular blocky structure parting to moderate very fine subangular blocky; slightly sticky; few very dark grayish brown (10YR 3/2) sandy coatings on peds; about 2 percent coarse fragments; many roots; neutral; clear wavy boundary.
B2t—11 to 16 inches; brown (10YR 4/3) clay loam; very dark grayish brown (10YR 3/2) clay films on peds; moderate medium angular blocky structure parting to moderate very fine subangular blocky; sticky; about 2 percent coarse fragments; many roots; neutral; clear smooth boundary.
B3—16 to 22 inches; olive brown (2.5Y 4/3) sandy clay loam; few fine distinct olive yellow (2.5Y 6/6) mottles; weak medium subangular blocky structure parting to weak very fine granular; slightly sticky; about 2 percent coarse fragments; few fine prominent yellowish red (5YR 4/8) concretions; thin dark grayish brown (10YR 4/2) clay coatings; many roots; neutral; gradual smooth boundary.
C1ca—22 to 32 inches; grayish brown (2.5Y 5/2) loam; many fine and medium prominent yellowish brown (10YR 5/6 & 5/8) and light gray (5Y 7/1) mottles; very friable; about 2 percent coarse fragments; few roots; violent effervescence; moderately alkaline; gradual smooth boundary.
C2ca—32 to 46 inches; grayish brown (2.5Y 5/2) loam; many medium prominent yellowish brown (10YR 5/6 & 5/8), white (5Y 8/1), and strong brown (7.5YR 5/8) mottles; weak and moderate medium angular blocky structure; very friable; about 2 percent coarse fragments; few roots to 36 inches; violent effervescence; moderately alkaline; gradual smooth boundary.
C3—46 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium and large prominent strong brown (7.5YR 5/6 & 5/8), dark brown (7.5YR 4/4), and white (5Y 8/1) mottles; weak fine angular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

Thickness of the solum and depth to free carbonates range from 22 to 38 inches. The mollic epipedon ranges from 8 to 16 inches in thickness. The content of coarse fragments ranges from 2 to 8 percent.

The A1 or Ap horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1 or 2. The A horizon typically is neutral or slightly acid.

The B horizon has hue of 2.5Y or 10YR, value of 3 through 5 (3 through 6, dry), and chroma of 2 through 4, moist or dry. It is clay loam, loam, sandy clay loam, or sandy loam. Reaction in the B horizon ranges from slightly acid to mildly alkaline. Clay films are thin to thick and patchy to continuous.

The C horizon has value of 5 or 6 and chroma of 2 through 4. Texture is commonly loam, but in some pedons it is clay loam or sandy loam. Calcium carbonate content of the C horizon is 10 to 30 percent.

Grimstad series

The Grimstad series consists of deep, somewhat poorly drained and moderately well drained, moderately permeable soils. These soils formed in a sandy mantle over loamy glacial or lacustrine deposits on lake plains. Slopes range from 0 to 3 percent.

Grimstad soils are commonly adjacent to Arveson, Hamerly, and Rockwell soils. They are similar to Elmville soils. Arveson soils are poorly drained and typically are on lower, slightly concave landscape positions. Hamerly soils do not have the contrasting sandy mantle and are on similar landscape positions, where these soils are on eroded till plains. Rockwell soils are poorly drained and are on lower, slightly concave landscape positions. Elmville soils are typically on more uniform landscapes. They formed in an upper mantle of mostly very fine sand over lacustrine clay.

Typical pedon of Grimstad fine sandy loam, 1,050 feet east and 105 feet north of the SW corner of sec. 4, T. 142 N., R. 45 W.:

A1—0 to 10 inches; black (10YR 2/1) fine sandy loam; very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak very fine granular structure; very friable; few fine bleached sand grains; many roots; strong effervescence; moderately alkaline; gradual smooth boundary.

A12ca—10 to 15 inches; very dark brown (10YR 2/2) fine sandy loam; gray (10YR 5/1) dry; weak medium subangular blocky structure parting to weak very fine granular; very friable; many roots; violent effervescence; strongly alkaline; clear smooth boundary.

C1ca—15 to 23 inches; dark grayish brown (10YR 4/2) loamy fine sand; weak very fine subangular blocky structure; very friable; many roots; violent effervescence; strongly alkaline; clear wavy boundary.

C2—23 to 31 inches; grayish brown (10YR 5/2) fine sand; single grain; loose; 2 percent coarse fragments; few roots; strong effervescence; strongly alkaline; clear smooth boundary.

C3—31 to 38 inches; light yellowish brown (2.5Y 6/3) fine sand; common fine and medium prominent yellowish brown (10YR 5/6 & 5/8) and yellowish red (5YR 4/6 & 4/8) mottles; single grain; loose; slight effervescence; strongly alkaline; abrupt smooth boundary.

IIC4—38 to 60 inches; light yellowish brown (2.5Y 6/3) loam; many medium and large prominent yellowish brown (10YR 5/6 & 5/8) mottles; weak very fine subangular blocky structure; friable; 3 percent coarse fragments; few fine prominent dark red (2.5YR 3/6) concretions; strong effervescence; strongly alkaline.

The mollic epipedon ranges in thickness from 7 to 16 inches. The top of the calcic horizon is within 16 inches of the surface. Depth to the loamy underlying material is 20 to 40 inches. Free carbonates are in all parts of the A and C horizons. Grimstad soils are mildly to moderately alkaline in the surface layer and mildly to strongly alkaline in the underlying material. In some pedons, a thin pebble band is at the contact of the upper sediment and the IIC horizon.

The A horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1 or 2. It is loamy fine sand, loamy very fine sand, sandy loam, fine sandy loam, or loam. Some pedons do not have an Aca horizon.

The Cca horizon has hue of 10YR or 2.5Y, value of 4 through 6 (6 through 8, dry), and chroma of 1 through 3. Texture is loamy sand, loamy fine sand, sandy loam, or fine sandy loam. The Cca horizon has a calcium carbonate content that ranges between 5 and 20 percent.

The rest of the C horizon above the IIC has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It commonly has mottles in most parts but there are no distinct or prominent mottles above a depth of 20 inches. Texture is sand, fine sand, loamy sand, or loamy very fine sand.

The IIC horizon has value of 5 or 6 and chroma of 2 through 4. It commonly has distinct or prominent mottles. It is loam, silt loam, fine sandy loam, clay loam, or silty clay loam. It is 15 to 35 percent calcium carbonate.

Hamerly series

The Hamerly series consists of deep, somewhat poorly drained and moderately well drained, moderately permeable, or moderately slowly permeable soils. These soils formed in water modified glacial till on upland landscapes or on lake-washed till plains. Slopes range from 1 to 4 percent.

Hamerly soils are commonly adjacent to Barnes, Flom, Kittson, and Vallers soils. They are similar to Bearden soils. Barnes soils are on higher and typically more rolling areas. Flom and Vallers soils are less calcareous in the solum, are poorly drained, and are in swales and depressions and on lower, less sloping areas. Kittson soils are less calcareous or noncalcareous in the solum and are on similar landscape positions. Bearden soils formed in lacustrine loamy material and do not have the coarse fragments common to Hamerly soils.

Typical pedon of Hamerly loam, 1 to 4 percent slopes, 83 feet south and 160 feet west of the NE corner of sec. 15, T. 140 N., R. 45 W.:

A1—0 to 10 inches; black (10YR 2/1) loam; very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 1 percent coarse fragments; many roots; strong effervescence; moderately alkaline; clear wavy boundary.

C1ca—10 to 24 inches; dark grayish brown (10YR 4/2) loam; weak medium subangular blocky structure; friable; about 1 percent coarse fragments; common roots; violent effervescence; moderately alkaline; clear smooth boundary.

C2ca—24 to 30 inches; pale brown (10YR 6/3) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; very friable; about 2 percent coarse fragments; few roots; violent effervescence; moderately alkaline; gradual smooth boundary.

C3—30 to 60 inches; light brownish gray (2.5Y 6/2) loam; many medium prominent yellowish brown (10YR 5/8), brownish yellow (10YR 6/6), and reddish yellow (7.5YR 6/8) mottles; weak medium angular blocky structure parting to weak very fine subangular blocky; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

The profile contains from 1 to 10 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 through 5, dry), and chroma of 1 or 2. It is dominantly loam, but silt loam and clay loam are within the range. It is moderately or mildly alkaline. Some pedons have an A12 or an A1ca horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 through 6 (5 through 8, dry), and chroma of 1 through 4. Texture is loam and light clay loam; and in some pedons, it is fine sandy loam below 30 inches.

Hegne series

The Hegne series consists of deep, poorly drained, very slowly permeable soils. These soils formed in clayey sediment on the lake plains. Slopes are typically 2 percent or less. These soils are subject to rare flooding.

In Clay County, Hegne soils are mapped only in complex with Fargo soils. Hegne soils are typically adjacent to Fargo soils and, in some areas, to Northcote and Viking soils. They are similar to Colvin soils. Fargo soils typically are on slightly lower positions and most commonly are on broad flats and in shallow swales. Northcote and Viking soils do not have a calcic horizon within 16 inches of the surface and are on positions similar to Fargo soils. Colvin soils formed in material that has less clay and more silt, with silty clay loam textures dominating. They are typically on low flats or in shallow swales.

Typical pedon of Hegne silty clay, from an area of Hegne-Fargo silty clays, 400 feet north and 1,960 feet east of the SW corner of sec. 29, T. 139 N., R. 48 W.:

Ap—0 to 9 inches; black (10YR 2/1) silty clay; very dark gray (10YR 3/1) dry; cloddy with some weak to moderate fine subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary broken by tongues of A horizon material extending to 30 inches.

C1gca—9 to 18 inches; dark gray (5Y 4/1) silty clay; moderate very fine subangular blocky structure; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C2gca—18 to 27 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6 & 5/8) mottles; moderate very fine subangular blocky structure; friable; sticky; strong effervescence; moderately alkaline; gradual smooth boundary.

C3gca—27 to 34 inches; olive gray (5Y 4/2) silty clay; many fine and medium prominent yellowish brown (10YR 5/6 & 5/8) and brownish yellow (10YR 6/6) mottles; weak very fine subangular blocky structure; friable; sticky; moderately strong effervescence; moderately alkaline; gradual smooth boundary.

C4g—34 to 60 inches; dark gray (5Y 4/1) clay; thin light gray (5Y 7/1) silt bands; many fine and medium prominent yellowish brown (10YR 5/8), brownish yellow (10YR 6/8), and olive yellow (2.5Y 6/6) mottles; moderate fine platy structure parting to moderate very fine angular blocky; sticky; slight effervescence; moderately alkaline.

Thickness of the mollic epipedon ranges from 7 to 16 inches. Free carbonates are in all parts, and the calcium carbonate content is 10 to 30 percent.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 through 5, dry), and chroma of 1. Some pedons are neutral in color. Texture is typically silty clay or clay but ranges to silty clay loam or clay loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6 (5 through 8, dry), and chroma of 1 or 2. Mottles are in some to all parts of the C horizon. Masses of gypsum crystals are in some pedons.

Kittson series

The Kittson series consists of deep, somewhat poorly drained and moderately well drained, moderately permeable to moderately slowly permeable soils. These soils formed in calcareous, loamy glacial till on uplands and lake-washed till plains. Slopes range from 0 to 5 percent.

Kittson soils are commonly adjacent to Hamerly, Flom, and Swenoda soils on water-modified till plains. They are commonly adjacent to Barnes and Darnen soils on terminal or end moraines. Kittson soils are similar to Gonvick soils. Hamerly soils are on similar landscape positions. They differ by being strongly calcareous at or near the surface. Flom soils are poorly drained and are on lower flat or slightly concave positions. Swenoda soils are on similar positions and have more sand in the upper part of the soil profile. Barnes soils are well drained and are on higher and commonly more sloping or rolling parts of the landscape. Darnen soils are moderately well drained and formed in colluvial material commonly located at the base of slopes. Gonvick soils are moderately well drained and are on similar landscape positions. They differ by having a more developed B horizon.

Typical pedon of Kittson fine sandy loam, 0 to 2 percent slopes, 2,555 feet south and 1,050 feet east of the NW corner of sec. 20, T. 142 N., R. 44 W.:

A1—0 to 10 inches; very dark brown (10YR 2/2) fine sandy loam; very dark gray (10YR 3/1) dry; medium angular blocky structure parting to weak very fine granular; very friable; many roots; neutral; clear wavy boundary.

B2—10 to 17 inches; dark grayish brown (10YR 4/2) streaks and blotches of very dark grayish brown (10YR 3/2) fine sandy loam; brown (10YR 4/3) dry; weak fine and medium subangular blocky parting to weak very fine granular; very friable; about 2 percent coarse fragments; many roots; neutral; clear smooth boundary.

C1ca—17 to 27 inches; light yellowish brown (2.5Y 6/3) loam; light yellowish brown (2.5Y 6/4) discoloration along root channels; weak very fine subangular blocky structure; very friable; about 2 percent coarse fragments; many roots; strong effervescence; moderately alkaline; clear smooth boundary.

C2—27 to 36 inches; light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) loam; common fine and medium distinct yellowish brown (10YR 5/6 & 5/8) and light gray (5Y 7/2) mottles; weak very fine subangular blocky structure; very friable; about 2 percent coarse fragments; many roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—36 to 60 inches; light olive gray (5Y 6/2) loam; many fine and medium prominent strong brown (7.5YR 5/6 & 5/8) and brownish yellow (10YR 6/6) mottles; weak and moderate very fine subangular blocky structure; very friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

Thickness of the solum and depth to free carbonates range from 15 to 30 inches. Thickness of the mollic epipedon ranges from 9 to 16 inches. Content of coarse fragments in the profile ranges from 2 to 10 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, or loam. The A horizon is neutral or mildly alkaline.

The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. In some pedons, the lower part of this horizon has mottles. This horizon is sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, or loam. Thin strata of loamy sand or coarser textures are in the B horizon of some pedons. Reaction is neutral or mildly alkaline.

The C horizon has value of 4 through 6 and chroma of 2 through 4. Texture is loam or clay loam. Reaction is mildly or moderately alkaline.

Langhei series

The Langhei series consists of deep, well drained, moderately permeable soils. These soils formed in loamy, calcareous glacial till on uplands. Slopes range from 2 to 18 percent.

In Clay County, Langhei soils are mapped only in complex with Barnes soils and Waukon soils. In places, Langhei soils are adjacent to Darnen soils. Barnes and Waukon soils are well drained and are commonly on areas adjacent to the crest of hills and on the break of steeper slopes where Langhei soils occur. Darnen soils are moderately well drained and typically are at the base of slopes.

Typical pedon of Langhei loam, from an area of Langhei-Barnes loams, 6 to 12 percent slopes; 2,740 feet north and 2,800 feet west of the SE corner of sec. 8, T. 139 N., R. 44 W.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam; light brownish gray (10YR 6/2) dry; weak very fine subangular blocky structure; very friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 17 inches; brown (10YR 5/3) loam; weak very fine subangular blocky structure; very friable; about 8 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—17 to 24 inches; yellowish brown (10YR 5/4) loam; pale brown (10YR 6/3) ped coatings; weak medium angular blocky structure; very friable; about 10 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—24 to 35 inches; light olive brown (2.5Y 5/4) loam; few fine prominent strong brown (7.5YR 5/6) iron stains; weak medium angular blocky structure; very friable; about 6 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C4—35 to 44 inches; yellowish brown (10YR 5/4) loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak moderate platy structure parting to weak and moderate angular blocky; very friable; about 8 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C5—44 to 60 inches; yellowish brown (10YR 5/4) loam; common fine light gray (5Y 7/1) streaks; few fine prominent yellowish red (5Y 5/6) iron concretions and few fine prominent reddish brown (5YR 5/4) soft iron stains; massive; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

This soil typically is 2 to 10 percent, by volume, coarse fragments. The control section is commonly loam throughout, but some pedons are light silty clay loam.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 through 5 (5.5 through 7, dry), and chroma of 1 or 2. The A horizon in noncultivated areas ranges from 2 to 4 inches in thickness. It has value of 2 or 3 and chroma of 1 or 2. Reaction in the A horizon ranges from neutral to moderately alkaline.

The C horizon has hue of 2.5Y or 10YR, value of 4 through 7, and chroma of 2 through 4. Mottles range from few to many and faint through distinct or are prominent in iron concretions and masses. Calcium carbonate content ranges from 15 to 35 percent.

Lohnes series

The Lohnes series consists of deep, moderately well drained and well drained, rapidly permeable soils. These soils formed in coarse sandy and gravelly sediments on beach ridges and outwash plains. Slopes range from 0 to 6 percent.

Lohnes soils are adjacent to Dickey, Maddock, and Sioux soils and are similar to Sverdrup soils. Dickey soils are on slightly lower or less convex positions than well drained Lohnes soils. They are on slightly higher or less concave positions than the moderately well drained Lohnes soils. Maddock soils are on landscape positions similar to well drained Lohnes soils. They do not have the gravel present in Lohnes soils. Sioux soils are excessively drained and typically are on more convex or sloping landscapes. They have more gravel-sized material than Lohnes soils. Sverdrup soils typically are on landscape positions similar to well drained Lohnes soils. They have finer textured upper sediments and less gravel in the underlying material.

Typical pedon of Lohnes coarse sandy loam, 1 to 6 percent slopes, 1,820 feet east and 5 feet south of the NW corner of sec. 3l, T. 141 N., R. 45 W.:

A1—0 to 9 inches; black (10YR 2/1) coarse sandy loam; very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; common bleached sand grains; many roots; neutral; clear smooth boundary.

B2—9 to 16 inches; very dark grayish brown (10YR 3/2) gravelly loamy coarse sand; brown (10YR 5/3) dry; weak very fine granular structure; very friable; 20 percent coarse fragments; few roots; slight effervescence; moderately alkaline; clear smooth boundary.

C1—16 to 23 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; 20 percent coarse fragments; few roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—23 to 60 inches; light yellowish brown (10YR 6/4) coarse sand; single grain; loose; 10 percent gravel-size materials; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 10 to 20 inches in thickness. The profile is typically coarse sand, sand, or loamy coarse sand in the fine earth fraction. The content of coarse fragments ranges from 0 to 35 percent. The soil reaction ranges from neutral to moderately alkaline.

The A1 horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1. Texture is sand, loamy coarse sand, loamy sand, coarse sandy loam, or sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 through 6 (4 through 8, dry), and chroma of 2 through 4. It has few or common mottles in some pedons.

Maddock series

The Maddock series consists of deep, well drained, rapidly permeable soils. These soils formed in sandy deposits on shorelines and outwash plains. Maddock soils are on uplands and lake plains. Slopes range from 0 to 12 percent.

Maddock soils are commonly adjacent to Lohnes, Sioux, and Sverdrup soils and are similar to Dickey soils. Lohnes and Sioux soils are on similar landscape positions, although ridges which have Lohnes or Sioux soils are typically more pronounced. Sverdrup soils are somewhat excessively drained and are on similar positions, typically on outwash deposits on upland landscapes. Dickey soils have contrasting loamy material within 40 inches of the surface.

Typical pedon of Maddock fine sand, 0 to 4 percent slopes, 400 feet north and 105 feet west of the SE corner of sec. 14, T. 138 N., R. 46 W.:

A1—0 to 10 inches; black (10YR 2/1) fine sand; very dark grayish brown (10YR 3/1) dry; weak fine medium subangular blocky structure parting to weak very fine granular; very friable; many bleached sand grains; common roots; neutral; clear smooth boundary.

B1—10 to 16 inches; very dark brown (10YR 2/2) fine sand; dark grayish brown (10YR 4/2) dry; weak fine medium subangular blocky structure parting to weak very fine granular; very friable; common roots; neutral; clear smooth boundary.

B2—16 to 23 inches; very dark grayish brown (10YR 3/2) fine sand; single grain; loose; few roots; neutral; gradual smooth boundary.

C1—23 to 31 inches; dark brown (10YR 3/3) sand; single grain; loose; few roots; neutral; clear smooth boundary.

C2—31 to 37 inches; brown (10YR 4/3) fine sand; single grain; loose; neutral; clear smooth boundary.

C3—37 to 60 inches; brown (10YR 5/3) fine sand; common fine faint yellowish brown (10YR 5/6) mottles; single grain; loose; neutral.

The profile is fine sand, loamy fine sand, or loamy sand. Soil reaction ranges from slightly acid to moderately alkaline. The mollic epipedon ranges from 10 to 16 inches in thickness.

The A horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1. Texture is loamy fine sand, loamy sand, fine sand, or sandy loam.

The B horizon has value of 2 through 5 (4 through 6, dry) and chroma of 2 through 4, moist or dry.

The C horizon has value of 3 through 6 (4 through 7, moist) and chroma of 2 through 4, moist or dry.

Markey series

The Markey series consists of deep, very poorly drained soils. These soils are on low flats and in depressions. They formed in highly decomposed organic material over sandy material on lake plains and in low areas associated with outwash plains on upland moraines. Permeability is moderately slow in the organic material and rapid in underlying sand. Slopes are commonly 0 to 2 percent. These soils are subject to ponding.

In Clay County, Markey soils are taxadjuncts to the Markey series because they contain carbonates in the organic soil material. This difference does not alter the use or behavior of these soils.

Markey soils are commonly adjacent to Arveson, Fossum, Rockwell, and Seelyeville soils. They are similar to Seelyeville soils. Arveson, Fossum, and Rockwell soils formed in mineral soil material and typically are on similar positions, commonly on lake plains. Seelyeville soils are on similar positions on lake plains and also on outwash and moraine areas. They have thicker accumulations of highly decomposed organic material.

Typical pedon of Markey muck, 2,110 feet south and 1,585 feet east of the NW corner of sec. 14, T. 141 N., R. 45 W.:

Oa1—0 to 12 inches; very dark gray (10YR 3/1) sapric material; black (10YR 2/1) rubbed; weak very fine granular structure; very friable; about 15 percent fibers; less than 5 percent rubbed; fibers are herbaceous; mildly alkaline; clear smooth boundary.

Oa2—12 to 20 inches; very dark gray (10YR 3/1) broken face and rubbed sapric material; about 3 percent fibers, about 1 percent rubbed; weak very fine granular structure; very friable; fibers are herbaceous; about 20 percent mineral; mildly alkaline; clear wavy boundary.

Oa3—20 to 24 inches; very dark gray (10YR 3/1) broken face and rubbed sapric material; weak fine platy structure; friable; fibers about 1 percent undisturbed and rubbed; fibers are herbaceous; 40 to 50 percent marl; mildly alkaline; clear broken boundary.

Oa4—24 to 28 inches; black (10YR 2/1) broken face and rubbed sapric material; weak very fine subangular blocky structure; very friable; about 3 percent fibers, about 1 percent rubbed; fibers are herbaceous; 30 percent mineral; mildly alkaline; abrupt smooth boundary.

IICg—28 to 60 inches; gray (2.5Y 5/1) sand; single grain; loose; mildly alkaline.

Depth to the sandy mineral substratum ranges from 20 to 50 inches. Reaction in the organic material ranges from medium acid to mildly alkaline. The 12-inch to 50-inch organic part of this soil is dominantly sapric material; however, some pedons have up to 10 inches of hemic material or up to 5 inches of fibric material. Composition of the fiber in the organic portion is primarily herbaceous; however, fragments of wood are in some pedons. The organic material has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 0 through 3. Thin discontinuous layers of limnic material that is grayer are in some pedons.

The IICg horizon is sand or loamy sand. It has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 0, 1, or 2. In some pedons, the upper 4 to 12 inches of the sandy material is black or very dark gray.

Northcote series

The Northcote series consists of deep, poorly drained, slowly permeable soils on lake plains. These soils formed in calcareous, clayey lacustrine sediment. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Northcote soils are commonly adjacent to Bearden, Colvin, and Fargo soils. Bearden soils are better drained and are on slightly elevated positions. Colvin and Fargo soils are on similar landscape positions. Colvin and Fargo soils have less clay in the solum than Northcote soils.

Typical pedon of Northcote clay, 240 feet east and 160 feet north of the SW corner of sec. 35, T. 138 N., R. 48 W.:

Ap—0 to 6 inches; black (10YR 2/1) clay; very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; sticky; mildly alkaline; abrupt smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) clay; very dark gray (10YR 3/1) films on peds; very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; sticky; neutral; gradual wavy boundary broken by tongues of A horizon material extending to 36 inches.

A13g—11 to 18 inches; very dark gray (5Y 3/1) clay; dark gray (5Y 4/1) dry; fine angular blocky structure; very sticky; neutral; gradual smooth boundary.

B2g—18 to 29 inches; dark gray (5Y 4/1) clay; many fine faint olive gray (5Y 4/2) mottles; weak very fine angular blocky structure; very sticky; few medium distinct light gray (5Y 7/1) lime masses; mildly alkaline; clear smooth boundary.

B3g—29 to 35 inches; dark gray (5Y 4/1) clay; many fine prominent reddish brown (2.5YR 4/4) mottles; moderate fine subangular blocky structure; sticky; few medium prominent white (5Y 8/1) lime masses; slight effervescence; mildly alkaline; gradual smooth boundary.

C1g—35 to 50 inches; dark gray (5Y 4/1) clay; many fine prominent reddish brown (2.5YR 4/4) mottles; moderate very fine angular blocky structure; sticky; common large prominent white (5Y 8/1) lime masses; slight effervescence; moderately alkaline; clear smooth boundary.

C2—50 to 60 inches; gray (5Y 5/1) clay; many fine and medium prominent reddish brown (2.5YR 4/4) and yellowish brown (10YR 5/6 & 5/8) mottles; weak fine angular blocky structure; very sticky; many medium distinct white (5Y 8/1) lime masses; slight effervescence; mildly alkaline.

Solum thickness ranges from 16 to 36 inches. Tongues of A horizon material extend to 48 inches in some pedons. Depth to free carbonates ranges from 12 to 30 inches.

The A horizon is 6 to 20 inches thick. It has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is neutral and has value of 2. Its reaction is neutral or mildly alkaline.

The B horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 or 2. It does not have mottles in some pedons. Reaction in the B horizon is neutral or mildly alkaline.

The C horizon has value of 4 or 5 and chroma of 1 or 2. Mottles are in at least some part of the horizon above 40 inches. Masses of gypsum crystals are in some pedons. Reaction is mildly or moderately alkaline.

Osakis series

The Osakis series consists of deep, moderately well drained soils. These soils formed in a loamy mantle over sandy material on uplands. They have moderate to moderately rapid permeability in the upper sediment and rapid permeability in the lower sediment. Slopes range from 1 to 3 percent.

Osakis soils are commonly adjacent to Kittson loam, Sioux and Sverdrup soils and are similar to Swenoda soils. Kittson loam soils are on landscape positions similar to Osakis soils. They formed in loamy till and do not have the gravelly underlying material. The Sverdrup soils are well drained. Typically they are higher on the landscape, and in some places they are more sloping. They formed in sand and do not have significant gravel in the underlying material. Sioux soils are excessively drained and typically are on higher and more sloping landscape positions. Swenoda soils do not have a significant layer of gravel and sand and have loamy material within 40 inches of the surface. They are on similar landscape positions.

Typical pedon of Osakis loam, 1,389 feet south and 270 feet west of the NE corner of sec. 36, T. 138 N., R. 44 W.:

Ap—0 to 8 inches; black (10YR 2/1) loam; very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; slightly acid; abrupt smooth boundary.

B2—8 to 17 inches; dark brown (10YR 3/3) sandy loam; brown (10YR 4/3) dry; moderate fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

IIC1ca—17 to 23 inches; grayish brown (10YR 5/2) gravelly loamy sand; few fine faint dark yellowish brown (10YR 4/4) mottles; single grain; loose; about 75 percent coarse fragments; moderately alkaline; strong effervescence; gradual wavy boundary.

IIC2—23 to 30 inches; grayish brown (10YR 5/2) gravelly loamy sand; common medium prominent yellowish brown (10YR 5/8) and brown (7.5YR 4/4) mottles; single grain; loose; about 80 percent coarse fragments; moderately alkaline; strong effervescence; gradual wavy boundary.

IIC3—30 to 60 inches; light brownish gray (2.5Y 6/2) gravelly coarse sand; many medium prominent yellowish brown (10YR 5/6) mottles; single grain; loose; about 40 percent coarse fragments; moderately alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 16 to 30 inches. Depth to sandy material ranges from 12 to 20 inches. The lower sediment contains from 20 to 65 percent coarse fragments. The solum is neutral or slightly acid.

The A1 or Ap horizon has value of 2 or 3 (3 or 4, dry) and chroma of 1. It is loam, light sandy clay loam, or heavy sandy loam. Some pedons have an A3 horizon that ranges up to 8 inches in thickness.

The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 through 4. It is mottled in the lower part in some pedons. Its texture is loam or sandy loam. A IIB horizon is in some pedons.

The IIC horizon has hue of 2.5Y or 10YR, value of 4 through 6, and chroma of 2 or 3. Mottles range from few to many and from faint to prominent.

Overly series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils. These soils formed in alluvial or lacustrine silty and clayey materials on lake plains, commonly near major streams. Slopes range from 0 to 3 percent.

Overly soils are commonly adjacent to Bearden, Colvin, Fargo, and Wheatville soils. Bearden and Wheatville soils are on similar or slightly lower landscape positions. They are calcareous in the upper sediment and have a calcic horizon within 16 inches of the surface. Colvin and Fargo soils are on lower positions on the landscape and are poorly drained.

Typical pedon of Overly silty clay loam, 2,100 feet east and 2,110 feet north of the SW corner of sec. 32, T. 140 N., R. 47 W.:

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam; dark gray (10YR 4/1) dry; weak to moderate very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A12—8 to 10 inches; black (10YR 2/1) silty clay loam; dark gray (10YR 4/1) dry; weak and moderate very fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

B2—10 to 16 inches; very dark grayish brown (10YR 3/2) grading to very dark gray (10YR 3/1) silty clay loam; dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

B3—16 to 19 inches; very dark grayish brown (10YR 3/2) silty clay loam; grayish brown (10YR 5/2) dry; weak very fine granular structure; very friable; neutral; clear smooth boundary.

C1ca—19 to 28 inches; light olive brown (2.5Y 5/3) silty clay; weak very fine subangular blocky structure; very friable; slightly sticky; moderate effervescence; mildly alkaline; gradual smooth boundary.

C2ca—28 to 43 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine and medium prominent yellowish brown (10YR 5/6 & 5/8) and dark yellowish brown (10YR 4/6 & 3/6) mottles; weak very fine angular blocky structure; very friable; strongly effervescent; mildly alkaline; gradual smooth boundary.

C3ca—43 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam banded with silt loam; common fine and medium brownish yellow (10YR 6/6 & 6/8) mottles; weak very fine angular blocky structure; very friable; strongly effervescent; moderately alkaline.

Thickness of the solum ranges from 16 to 36 inches. Soil reaction ranges from neutral to moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4, dry) and chroma of 1, moist or dry. It is a silty clay loam or, less commonly, silt loam, clay loam, or silty clay.

The B2 horizon has hue of 10YR or 2.5Y, value of 2 through 4 (3 through 5, dry), and chroma of 1 through 3, moist or dry. The B3 horizon has hue of 2.5Y or 10YR, value of 3 through 5 (4 through 7, dry), and chroma of 1 through 3, moist or dry.

The Cca horizon has hue of 2.5Y or 10YR, value of 4 through 6 (6 or 7, dry), and chroma of 2 through 4, moist or dry. The Cca horizon has from 15 percent to over 30 percent calcium carbonate. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 through 4. Mottles in the lower Cca and C horizons range from few to many and from faint to prominent. Lower horizons in these soils are commonly laminated with silt, silty clay loam, or silty clay.

Poppleton series

The Poppleton series consists of deep, somewhat poorly drained and moderately well drained, rapidly permeable soils. These soils formed in sandy deposits on lake plains. Slopes range from 0 to 2 percent.

Poppleton soils are commonly adjacent to Flaming, Fossum, and Ulen soils. Flaming and Ulen soils typically are on similar landscape positions. They differ by having a darker colored surface layer. Fossum soils are poorly drained and are on lower, typically plane or slightly concave positions.

Typical pedon of Poppleton fine sand, 520 feet west and 2,630 feet north of the SE corner of sec. 23, T. 142 N., R. 45 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) fine sand; very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; many roots; medium acid; abrupt smooth boundary.

B1—8 to 14 inches; dark brown (10YR 4/3) sand; single grain; loose; many roots; neutral; clear smooth boundary.

B2—14 to 20 inches; brown (10YR 5/3) fine sand; few fine distinct dark grayish brown (10YR 4/2) mottles; single grain; very friable to loose; many roots; neutral; clear smooth boundary.

B3—20 to 25 inches; pale brown (10YR 6/3) fine sand; few fine distinct dark grayish brown (10YR 4/2) mottles; common large prominent dark yellowish brown (10YR 4/4) and common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; neutral; clear smooth boundary.

B32—25 to 31 inches; grayish brown (2.5Y 5/2) fine sand; few fine distinct olive yellow (2.5Y 6/6) and light yellowish brown (2.5Y 6/4) mottles; single grain; loose; mildly alkaline; clear smooth boundary.

C1—31 to 60 inches; light brownish gray (2.5Y 6/2) fine sand; many medium prominent yellowish brown (10YR 5/8), brownish yellow (10YR 6/6), and dark brown (7.5YR 4/4) mottles; single grain; loose; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 55 inches. Reaction ranges from medium acid in the upper part to mildly alkaline in the lower part.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 or 2, moist or dry. Some pedons have an A2 horizon, which has hue of 10YR, value of 4 or 5, and chroma of 2. The A horizon is fine sand, loamy fine sand, or sand.

The B horizon has value of 5 or 6 and chroma of 3 or 4. In some pedons, it has a moist value of 4 in the upper part.

The C horizon has hue of 10YR or 2.5Y, value of 5 through 7, and chroma of 2.

Quam series

The Quam series consists of deep, very poorly drained, moderately slowly permeable soils. These soils are in depressions and drainageways on uplands. Quam soils formed in noncalcareous, loamy colluvial and alluvial deposits over loamy, calcareous glacial till. Slopes range from 0 to 2 percent. These soils are subject to ponding.

In Clay County, the Quam soils are taxadjuncts to the Quam series. They are outside the range defined for the series because they contain more sand in the profile. This difference does not alter the use or behavior of these soils.

Quam soils are commonly adjacent to Darnen, Flom, Urness, and Vallers soils. Darnen soils are on higher positions than the Quam soils and formed in colluvial material at the base of steeper slopes. Flom and Vallers soils are on similar landscape positions and have a thinner mollic epipedon. Urness soils formed in coprogenous earth and are on similar landscape positions.

Typical pedon of Quam clay loam, 660 feet west and 2,970 feet north of the SE corner of sec. 27, T. 137 N., R. 44 W.:

A11—0 to 12 inches; black (10YR 2/1) clay loam; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A12—12 to 23 inches; black (10YR 2/1) loam; weak medium subangular blocky structure parting to weak very fine granular structure; very friable; few clean sand grains; slight effervescence; mildly alkaline; gradual smooth boundary.

A13—23 to 41 inches; black (N 2/0) clay loam; weak and moderate medium subangular blocky structure parting to weak very fine granular; very friable; neutral; clear smooth boundary.

A14—41 to 49 inches; black (10YR 2/1) clay loam; few fine prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; massive; sticky; 2 percent coarse fragments; neutral; gradual smooth boundary.

A15—49 to 60 inches; black (10YR 2/1) clay loam; common medium light brownish gray (2.5Y 6/2) lime concretions; massive; sticky; 1 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

C1gca—60 to 65 inches; gray (2.5Y 5/1) clay loam; massive; slightly sticky; 2 percent coarse fragments; strong effervescence; mildly alkaline.

Thickness of the mollic epipedon typically ranges from 30 to 60 inches. Depth to free carbonates ranges from 30 to 70 inches. The content of coarse fragments ranges from 0 to 5 percent.

The A horizon is neutral, or it has hue of 10YR, 2.5Y, or 5Y. Value is 2 in the upper part and 2 or 3 in the lower part. Chroma is 1 or 0. Mottles are not present in the A horizon of some pedons. The A horizon is silty clay loam, silt loan, or loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. Mottling is commonly distinct and prominent but is not present in some pedons. Texture is loam, silt loam, silty clay loam, or clay loam. Reaction is neutral to moderately alkaline.

Rockwell series

The Rockwell series consists of deep, poorly drained and very poorly drained, moderately permeable to moderately slowly permeable soils. These soils formed in a loamy and sandy mantle over loamy glacial or lacustrine deposits on lake plains. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Rockwell soils are commonly adjacent to Arveson, Grimstad, and Vallers soils. They are similar to Augsburg soils. Arveson soils do not have a IIC horizon of loamy or silty glacial till within 40 inches of the surface and are on similar positions on the landscape. Grimstad soils are somewhat poorly drained and moderately well drained and typically are on slightly higher, somewhat convex landscape positions. Vallers soils typically are on positions similar to Rockwell soils when mapped on lake-washed till plains. They do not have the sandy layer that is in Rockwell soils. Augsburg soils are typically on more uniform landscapes. They formed in an upper mantle of mostly very fine sand and silt over lacustrine clay.

Typical pedon of Rockwell clay loam, 315 feet east and 1,050 feet south of the NW corner of sec. 30, T. 142 N., R. 44 W.:

A1—0 to 9 inches; black (N2/0) clay loam; very dark gray (N 3/0) dry; weak very fine granular structure; very friable; common fine bleached sand grains; abundant roots; strong effervescence; moderately alkaline; clear smooth boundary.

C1ca—9 to 14 inches; very dark gray (5Y 3/1) clay loam; gray (2.5Y 5/1) dry; weak very fine subangular blocky structure; very friable; abundant roots; violent effervescence; moderately alkaline; clear smooth boundary.

C2ca—14 to 18 inches; dark olive gray (5Y 3/2) fine sandy loam; gray (10YR 5/1) dry; single grain; loose; common roots; violent effervescence; strongly alkaline; clear smooth boundary.

C3—18 to 22 inches; gray (2.5Y 5/1) fine sand; single grain; loose; few roots; strong effervescence; strongly alkaline; clear smooth boundary.

C4—22 to 28 inches; gray (2.5Y 6/1) loamy fine sand; few fine and medium distinct olive yellow (2.5Y 6/6) mottles; single grain; loose; few roots; strong effervescence; strongly alkaline; abrupt smooth boundary.

IIC5—28 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common fine and medium distinct olive yellow (2.5Y 6/6 & 6/8) and light olive brown (2.5Y 5/6) mottles; massive; slightly sticky; 2 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon ranges in thickness from 7 to 18 inches. The top of the calcic horizon is within 16 inches of the surface. Depth to the top of the IIC horizon ranges from 20 to 40 inches. Reaction ranges from mildly to moderately alkaline in the A horizon and from mildly to strongly alkaline in the C horizon.

The A horizon is neutral and has value of 2 or 3; or it has hue of 10YR through 5Y, value of 2 or 3, and chroma of 1. It is sandy loam, fine sandy loam, loam, clay loam, or sandy clay loam. It has slight to violent effervescence. Some pedons have an Aca horizon.

The Cca horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 through 5, and chroma of 1 or 2. This horizon has mottles in some pedons. It is sandy loam, fine sandy loam, or loam. It has strong or violent effervescence. Masses of A horizon and Cca horizon material are mixed in some pedons. The Cca has a calcium carbonate content of 15 to 40 percent.

The C horizon between the Cca and IIC has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 1 or 2. It has distinct and prominent mottles in most parts. Texture is sand, fine sand, loamy sand, and loamy fine sand. Effervescence is slight or strong.

The IIC horizon has color range and mottling similar to the C horizon. Texture is loam, silt loam, sandy loam, fine sandy loam, very fine sandy loam, clay loam, or silty clay loam.

Rondeau series

The Rondeau series consists of deep, very poorly drained, moderately slowly permeable and slowly permeable soils. These soils formed in highly decomposed organic material and in underlying coprogenous earth and marl deposits. They generally are in upland depressions. Slopes are less than 2 percent. These soils are subject to ponding.

In Clay County, Rondeau soils are taxadjuncts to the Rondeau series. They are outside the range defined for the series because they contain coprogenous earth in the underlying material and because the depth to marl is too great. These differences do not alter the use or behavior of these soils.

Rondeau soils are commonly adjacent to Flom soils. They are similar to and commonly adjacent to Cathro, Seelyeville, and Urness soils. Flom soils are on slightly elevated positions and formed in mineral soil material. Cathro and Seelyeville and Urness soils are on similar landscape positions. Cathro soils have an organic surface underlain by loamy mineral material. Seelyeville soils formed entirely in highly decomposed organic material. Urness soils differ by having formed mostly in coprogenous earth.

Typical pedon of Rondeau muck, 1,320 feet east and 170 feet south of the NW corner of sec. 6, T. 137 N., R. 44 W.:

Oa1—0 to 8 inches; very dark grayish brown (2.5Y 3/2) sapric material; very dark gray (2.5Y 3/1) rubbed; weak to moderate fine granular structure; very friable; about 30 percent fiber; about 10 percent rubbed; about 3 percent snail shells; mildly alkaline; gradual smooth boundary.

Oa2—8 to 16 inches; very dark gray (10YR 3/1) sapric material; black (10YR 2/1) rubbed; weak very fine granular structure; very friable; about 20 percent fiber; less than 5 percent fiber rubbed, about 20 percent mineral content; about 2 percent snail shells; mildly alkaline, clear smooth boundary.

Oe—16 to 23 inches; dark grayish brown (2.5Y 4/2) hemic material; very dark brown (10YR 2/2) rubbed; weak very fine granular structure; very friable; about 80 percent fiber; 25 to 30 percent fiber rubbed; about 10 percent mineral content; about 1 percent snail shells; mildly alkaline; clear smooth boundary.

Oa3—23 to 50 inches; black (10YR 2/1) sapric material; weak very fine granular structure; very friable; less than 5 percent fiber content undisturbed and rubbed; about 30 percent mineral content; about 5 percent snail shells; mildly alkaline; gradual smooth boundary.

Lco1—50 to 105 inches; black (10YR 2/1), very dark gray (10YR 3/1) rubbed, coprogenous earth; about 50 percent mineral content; weak fine granular structure; very friable; 10 percent shell fragments; moderately alkaline; clear smooth boundary.

Lca—105 to 130 inches; light gray (10YR 6/1 & 7/1) marl; about 70 percent mineral content, of which about 40 percent is shell remains; massive; slightly sticky.

Thickness of organic material over limnic material ranges from 16 to 51 inches. Some pedons which have limnic material below 35 inches have significant layers of hemic material. The sapric material has hue of 10YR or 25.Y, value of 2 or 3, and chroma of 1 or 2. The hemic material has hue of 10YR, value of 2 through 4, and chroma of 2 or 3. The organic material is neutral or mildly alkaline.

The Lco layer has hue of 10YR, 2.5Y, or 5Y, value of 2 through 4, and chroma of 1 or 2. Snail shells are common and make up to 25 percent by volume of this material. The Lca layer has hue of 10YR, 2.5Y, or 5Y, value of 5 through 7, and chroma of 1 or 2. Snail shells compose 5 to 50 percent of this layer.

Seelyeville series

The Seelyeville series consists of deep, very poorly drained, moderately rapidly permeable to moderately slowly permeable soils. These soils formed in highly decomposed organic material in broad swales or closed depressions generally on uplands. Slopes are less than 2 percent. These soils are subject to ponding.

Seelyeville soils are commonly adjacent to Arveson and Flom soils. They are similar to Cathro, Markey, and Rondeau soils. Arveson soils formed in mineral soil material and are commonly in areas influenced by seepage at the base of slopes. Flom soils formed in mineral soil material and are on slightly higher positions than Seelyeville soils. Cathro and Markey soils formed in less than 51 inches of organic soil material. Rondeau soils have limnic sediment within the control section.

Typical pedon of Seelyeville muck, 1,320 feet south and 400 feet east of the NW corner of sec. 12, T. 138 N., R. 44 W.:

Oa1—0 to 16 inches; very dark brown (10YR 2/2) sapric material; very dark grayish brown (10YR 3/2) rubbed; weak very fine granular structure; very friable; about 25 percent fiber, about 5 percent rubbed; about 15 percent mineral matter; neutral; gradual smooth boundary.

Oa2—16 to 30 inches; dark brown (7.5YR 4/3) sapric material; very dark grayish brown (10YR 3/2) rubbed; weak very fine granular structure; very friable; about 25 percent fiber, about 10 percent rubbed; about 10 percent mineral matter; neutral; clear smooth boundary.

Oa3—30 to 60 inches; very dark grayish brown (10YR 3/2) sapric material; black (10YR 2/1) rubbed; weak very fine granular structure; very friable; about 20 percent fiber, about 5 percent rubbed; about 20 percent mineral matter; neutral; clear smooth boundary.

The thickness of the organic material exceeds 51 inches. The content of mineral material in the organic layer ranges from 10 to 40 percent. Reaction in the control section ranges from strongly acid through neutral.

The sapric material has rubbed hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Some pedons have thin strata of hemic material that have hue of 10YR, value of 2 or 3, and chroma of 2 or 3.

Sioux series

The Sioux series consists of excessively drained soils that have moderately rapid permeability in the upper part and rapid permeability in the lower part. These soils formed in loamy sediment and sandy underlying sediment on beach ridges and outwash plains. Slopes range from 1 to 30 percent.

Sioux soils are commonly adjacent to Arveson, Lohnes, Maddock, and Osakis soils. Arveson soils are poorly drained and very poorly drained and are on low, wet areas that have a high water table. Lohnes soils are moderately well drained and well drained and are on similar or slightly lower positions on the landscape. Maddock soils are well drained and are commonly on similar landscape positions. Osakis soils are moderately well drained and are on slightly lower, typically less ridgelike positions.

Typical pedon of Sioux sandy loam, 1 to 6 percent slopes, 1,800 feet south and 1,793 feet west of the NE corner of sec. 13, T. 140 N., R. 46 W.:

A1—0 to 9 inches; black (10YR 2/1) sandy loam; very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; very friable; few roots; about 5 percent coarse fragments; mildly alkaline; clear smooth boundary.

AC—9 to 14 inches; dark brown (10YR 3/3) gravelly loamy coarse sand; weak very fine granular structure; very friable; few roots; about 40 percent coarse fragments; neutral; slight effervescence; clear wavy boundary.

C1—14 to 26 inches; brown (10YR 4/3) gravelly loamy coarse sand; single grain; loose; few roots; about 70 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C2—26 to 40 inches; yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) gravelly loamy coarse sand; single grain; loose; few roots; about 70 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C3—40 to 50 inches; light yellowish brown (10YR 6/4) gravelly loamy coarse sand; single grain; loose; few roots; about 70 percent coarse fragments; few fine prominent (10YR 4/8) iron concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C4—50 to 60 inches; light yellowish brown (10YR 6/4) gravelly loamy coarse sand; single grain; loose; about 70 percent coarse fragments; few shale fragments; strong effervescence; moderately alkaline.

Solum thickness ranges from 6 to 14 inches. Depth to free carbonates commonly ranges from 3 to 9 inches, but some pedons are calcareous on the surface. The mollic epipedon ranges from 7 to 14 inches in thickness. In some pedons scattered boulders are on the surface, and in some they also are in the underlying material.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4, dry), and chroma of 1 or 2, moist or dry. It is loam, gravelly loam, sandy loam, gravelly sandy loam, loamy sand, gravelly loamy sand, or bouldery loamy coarse sand. Reaction is neutral through moderately alkaline. The AC horizon has value of 3 or 4 and chroma of 1.5 through 3.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4.

Sverdrup series

The Sverdrup series consists of deep, somewhat excessively drained soils that are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils are on uplands. They formed in outwash materials that have a loamy upper sediment and sandy underlying material. Slopes range from 1 to 12 percent.

Sverdrup soils are commonly adjacent to Barnes, Kittson, Maddock, and Sioux soils. Barnes soils formed in loamy till and are on moraine deposits that typically have more complex topography. Kittson soils are somewhat poorly drained and are commonly on lower landscape positions. Maddock soils are on similar landscape positions and have sandier upper sediment. Sioux soils are excessively drained and are commonly on higher knobs, the break of slopes, or the top of ridges.

Typical pedon of Sverdrup sandy loam, 1 to 4 percent slopes, 99 feet south and 1,320 feet east of the NW corner of sec. 1, T. 137 N., R. 44 W.:

A1—0 to 9 inches; black (10YR 2/1) sandy loam; very dark grayish brown (10YR 3/2) dry; weak very fine and fine granular structure; very friable; common roots; neutral; clear smooth boundary.

B2—9 to 16 inches; dark brown (10YR 3/3) sandy loam, dark yellowish brown (10YR 3/4) dry; weak very fine granular structure; very friable; common roots; neutral; gradual smooth boundary.

B3—16 to 21 inches; dark brown (10YR 4/4) loamy sand; weak medium subangular blocky structure parting to weak very fine granular; very friable; many roots; neutral; clear wavy boundary.

C1—21 to 39 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; neutral; clear smooth boundary.

C2—39 to 47 inches; mixed dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loamy sand; single grain; loose; strong effervescence; moderately alkaline; clear smooth boundary.

C3—47 to 60 inches; mixed pale brown (10YR 6/3) and light gray (10YR 7/2) sand; single grain; loose; strong effervescence; moderately alkaline.

Solum thickness ranges from 16 to 30 inches. The depth to free carbonates ranges from 15 to 40 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically sandy loam or fine sandy loam, but in places it is loam. The thickness of the A horizon ranges from 8 to 16 inches.

The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 through 4. The B2 horizon is sandy loam, fine sandy loam, or loam. The B3 horizon is loamy sand, loamy fine sand, fine sandy loam, or sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. The C horizon is fine sand, sand, or loamy sand.

Swenoda series

The Swenoda series consists of deep, moderately well drained soils. These soils formed in loamy upper sediment over loamy or silty glacial or lacustrine material. They are on lake plains, on lake-washed till plains, or on uplands associated with outwash deposits. They have moderately rapid permeability in the upper sediment and moderate to moderately slow permeability in the lower material. Slopes range from 1 to 4 percent.

Swenoda soils are commonly adjacent to Foldahl, Grimstad, Kittson, and Sverdrup soils. Foldahl and

Kittson soils have a coarser textured mantle and are on similar positions on the landscape. Grimstad and Sverdrup soils are calcareous at or near the surface and are on slightly lower landscape positions.

Typical pedon of Swenoda sandy loam, 1 to 4 percent slopes, 1,215 feet east and 1,210 feet north of the SW corner of sec. 13, T. 137 N., R. 45 W.:

A1—0 to 13 inches; black (10YR 2/1) sandy loam; very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; neutral; clear smooth boundary.

B2—13 to 24 inches; very dark brown (10YR 2/2) sandy loam; very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; very friable; neutral; clear smooth boundary.

B3—24 to 32 inches; brown (10YR 4/3) loamy sand; few fine distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; single grain; very friable to loose; a lag line about 2 inches thick of coarse gravel and a few cobblestones at the base of this horizon; neutral; abrupt smooth boundary.

IIC1—32 to 60 inches; grayish brown (2.5Y 5/3) loam; few fine and medium prominent dark brown (7.5YR 4/4) concretions; massive; friable; strong effervescence; moderately alkaline.

Solum thickness and depth to the IIC horizon range from 20 to 40 inches.

The A or Ap horizon has value of 2 or 3 (3 or 4, dry) and chroma of 1.5 or less, moist or dry. The A horizon below a depth of 7 inches has similar color except that chroma is 1 or 2, moist or dry. Texture is fine sandy loam, sandy loam, loam, or loamy fine sand. Reaction is slightly acid or neutral.

The B horizon has hue of 10YR or 2.5Y, value of 2 through 4 (3 through 6, dry), and chroma of 2 through 4, moist or dry. Mottles are not present in the lower part of this horizon in some pedons. Texture is fine sandy loam, sandy loam, loamy sand, or loamy fine sand. Reaction is neutral or mildly alkaline.

The IIC horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4. It is silt loam, loam, clay loam, or silty clay loam. The IIC horizon has a calcium carbonate content of 15 to 30 percent.

Syrene series

The Syrene series consists of deep, poorly drained soils. These soils formed in loamy upper sediment over gravelly sandy material. They are on lake plains, generally near beach deposits. They have moderately rapid permeability in the upper part and rapid permeability in the underlying material. Slopes range from 0 to 2 percent.

Syrene soils are commonly adjacent to Arveson, Markey, and Lohnes soils. Arveson soils have a fine sand substratum and are on similar landscape positions. Markey soils formed in organic soil material and are on similar landscape positions. Lohnes soils are moderately well drained and are typically on adjacent ridges and higher, more sloping areas.

Typical pedon of Syrene sandy clay loam, 700 feet east and 500 feet south of the NW corner of sec. 1, T. 142 N., R. 45 W.:

A1—0 to 9 inches; very dark gray (10YR 3/1) sandy clay loam; dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak very fine granular; very friable; strong effervescence; mildly alkaline; clear smooth boundary.

C1gca—9 to 17 inches; dark gray (2.5Y 4/1) sandy clay loam; weak very fine granular structure; very friable; violent effervescence; moderately alkaline; clear smooth boundary.

IIC2ca—17 to 27 inches; light brownish gray (2.5Y 6/2) gravelly fine sand; common medium and distinct brownish yellow (10YR 6/6) and a few fine and prominent yellowish brown (10YR 5/8) mottles; single grain; loose; 25 percent gravel; violent effervescence; moderately alkaline; gradual smooth boundary.

IIC3—27 to 60 inches; light olive gray (5Y 6/2) gravelly fine sand; many fine and medium prominent yellowish brown (10YR 5/6 & 5/8) and common large prominent dark brown (7.5YR 4/4) and strong brown (7.5YR 5/8) mottles; single grain; loose; 35 percent gravel; strong effervescence; moderately alkaline.

The mollic epipedon ranges in thickness from 8 to 16 inches. The calcic horizon is 6 to 20 inches thick. Soil reaction is mildly or moderately alkaline. Thickness of the loamy upper sediment ranges from 12 to 24 inches. The lower sediment has 10 to 35 percent coarse fragments.

The A horizon is neutral and has value of 2 or 3, or it has hue of 10YR through 5Y, value of 2 or 3, moist, and chroma of 1. It is sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, loam, or silt loam. It has no coarse fragments or has less than 10 percent coarse fragments.

The C horizon in the upper sediment is neutral and has value of 4 through 6, or it has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It has texture similar to the A horizon.

The IIC horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. Mottling ranges from few to many and faint to prominent. Texture is coarse sand, sand, fine sand, loamy coarse sand, or loamy sand. These textures typically have gravelly modifiers.

Ulen series

The Ulen series consists of deep, somewhat poorly drained and moderately well drained, rapidly permeable soils. These soils formed in calcareous loamy and sandy deposits on lake plains. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Ulen soils are commonly adjacent to Arveson, Flaming, and Fossum soils. They are similar and, in places, adjacent to Grimstad and Wyndmere soils. Arveson soils are poorly drained or very poorly drained and are on lower, concave and depressional positions. Flaming soils are on similar landscape positions and have a coarser textured surface layer that is noncalcareous. Fossum soils are poorly drained and are on lower, slightly concave positions on similar landscapes. Grimstad soils have a loamy lower substratum. Wyndmere soils have more clay in the upper 40 inches of the profile.

Typical pedon of Ulen fine sandy loam, 680 feet east and 940 feet north of the SW corner of sec. 26, T. 141 N., R. 46 W.:

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam; dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A12ca—8 to 13 inches; very dark gray (10YR 3/1) fine sandy loam; gray (10YR 5/1) dry; weak medium subangular blocky structure; very friable; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—13 to 19 inches; dark grayish brown (10YR 4/2) sandy loam; weak very fine granular structure; very friable; violent effervescence; moderately alkaline; clear smooth boundary.

C2ca—19 to 25 inches; grayish brown (10YR 5/2) loamy fine sand; single grain; loose; strong effervescence; moderately alkaline; clear wavy boundary.

C3—25 to 33 inches; light olive brown (2.5Y 5/3) loamy fine sand; single grain; loose; slight effervescence; moderately alkaline; clear smooth boundary.

C4—33 to 41 inches; olive yellow (2.5Y 6/6) fine sand; many medium distinct brown (7.5YR 4/4) mottles; single grain; loose; slight effervescence; moderately alkaline; clear smooth boundary.

C5—41 to 60 inches; light brownish gray (2.5Y 6/2) fine sand; many medium distinct light yellowish brown (2.5Y 6/4) and olive yellow (2.5Y 6/6) and common fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; slight effervescence; moderately alkaline.

Thickness of the mollic epipedon ranges from 10 to 20 inches. An accumulation of free carbonates that has 5 to 20 percent calcium carbonate content is in the lower A horizon and upper C horizons.

The A horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1 or 2. The A horizon is loamy fine sand, loamy very fine sand, sandy loam, and fine sandy loam.

The Cca horizon has value of 4 or 5 and chroma of 1 through 3, or it has hue of 2.5Y, value of 4 or 5, and chroma of 2 or 3. Texture is loamy sand, loamy fine sand, sandy loam, or fine sandy loam.

The rest of the C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 6. Mottling in this part of the C horizon is distinct or prominent. Texture is fine sand or loamy fine sand, and some pedons have strata of very fine sand and sand.

Urness series

The Urness series consists of deep, very poorly drained, moderately to moderately slowly permeable soils. These soils are in former lakes and sloughs that commonly were associated with upland landscapes. Urness soils formed in coprogenous earth. Slopes are less than 1 percent. These soils are subject to ponding.

Urness soils are commonly adjacent to areas of Flom and Quam soils. Flom soils do not have the calcareous coprogenous earth deposits. They are commonly on slightly higher portions of the landscape. Quam soils are on similar positions on the landscape. They formed in less calcareous clay loam colluvial material.

Typical pedon of Urness mucky silt loam, 530 feet south and 150 feet west of the NE corner of sec. 33, T. 138 N., R. 44 W.:

Lco1—0 to 10 inches; very dark gray (10YR 3/1) mucky silt loam; weak medium subangular blocky structure parting to weak very fine granular structure; very friable; about 2 percent shell fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Lco2—10 to 15 inches; very dark gray (2.5Y 3/1) mucky silt loam; weak medium subangular blocky structure parting to weak very fine granular; very friable; about 5 percent shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Lco3—15 to 24 inches; very dark gray (2.5Y 3/1) mucky silt loam; many medium prominent reddish brown (5YR 4/4) and yellowish red (5YR 4/6) stains on remains of plant fibers; weak medium subangular blocky structure parting to weak very fine granular; very friable; about 5 percent shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Lco4—24 to 37 inches; very dark gray (2.5Y 3/1) mucky silt loam; common large prominent dark reddish brown (5YR 3/4) stains on plant fibers; weak coarse angular blocky structure parting to weak very fine subangular blocky; very friable; about 2 percent shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Lco5—37 to 58 inches; black (N 2/0) mucky silt loam; common fine prominent reddish brown (5YR 4/4) mottles; weak coarse angular blocky structure parting to weak very fine subangular blocky; very friable; about 1 percent shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Lco6—58 to 60 inches; very dark gray (2.5Y 3/1) mucky silt loam; weak coarse angular blocky structure parting to weak very fine subangular blocky; very friable; light gray (N 7/0) fine sand coatings on ped faces; about 1 percent shell fragments; slight effervescence; moderately alkaline; clear smooth boundary.

Thickness of lake sediment (coprogenous earth) ranges from 30 to more than 80 inches. Coarse fragments are almost all shell fragments that make up 1 to 25 percent of the volume of the lake sediment. These soils have hue of 10YR, 2.5Y, or 5Y, value of 2 through 4, and chroma of 1 or 2. Neutral colors that have value of 2 or 3 are also in the range. Organic matter content of this sediment ranges from 10 to 50 percent. Reaction is mildly or moderately alkaline. In some pedons, contrasting mineral material is present. It has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or 2. It is loam, silt loam, clay loam, or silty clay loam.

Vallers series

The Vallers series consists of deep, poorly drained, moderately slowly permeable soils. These soils formed in calcareous loamy glacial till on uplands or lake-washed till plains. Slopes range from 0 to 2 percent. These soils are subject to rare flooding.

Vallers soils are commonly adjacent to Grimstad, Hamerly, Kittson, and Rockwell soils. They are similar to Colvin soils. Grimstad, Hamerly, and Kittson soils are somewhat poorly drained and moderately well drained and are on slightly higher, convex landscape positions. Rockwell soils are on similar positions. They differ by having a sandy layer over the contrasting silt loam or loam material. Colvin soils formed in lacustrine silty clay loam and are on nearly level lake plain landscapes.

Typical pedon of Vallers loam, 277 feet west and 200 feet north of the SE corner of sec. 17, T. 140 N., R. 44 W.:

A1—0 to 9 inches; black (10YR 2/1) loam; very dark gray (2.5Y 3/1) dry; weak and moderate very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A12ca—9 to 13 inches; very dark gray (10YR 3/1) loam; dark gray (5Y 4/1) dry; weak and moderate very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

C1ca—13 to 20 inches; gray (5Y 4/1) clay loam; weak very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual wavy boundary.

C2ca—20 to 26 inches; gray (5Y 5/1) clay loam; common fine and medium distinct yellowish brown (10YR 5/6 & 5/8) and brownish yellow (10YR 6/8) mottles; weak very fine and fine subangular blocky structure; very friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C3g—26 to 35 inches; olive gray (5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/8) and common fine prominent dark brown (7.5YR 4/4) mottles; weak very fine subangular blocky structure; slightly sticky; strong effervescence; moderately alkaline; gradual smooth boundary.

C4g—35 to 60 inches; olive gray (5Y 5/2) loam; common fine and medium distinct yellowish brown (10YR 5/6 & 5/8) mottles; weak very fine subangular blocky structure; slightly sticky; strong effervescence; moderately alkaline.

The A horizon is neutral and has value of 2 or 3, or it has hue of 10YR, 2.5Y, or 5Y, value of 2 to 3 (3 through 5, dry), and chroma of 1 or 2. Texture of the A horizon is loam, silt loam, clay loam, or silty clay loam. Mottles are in the lower part of the A horizon in some pedons. Reaction is moderately or mildly alkaline. The Aca horizon is not present in all pedons.

The Cca horizon has hue of 2.5Y or 5Y, value of 3 through 6, and chroma of 1 or 2. It commonly has few to many fine or medium, faint to prominent mottles. Texture is clay loam, loam, or silty clay loam.

The rest of the C horizon has hue of 2.5Y or 5Y, value of 4 through 7, and chroma of 1 through 3. Texture is loam or clay loam.

Viking series

The Viking series consists of deep, poorly drained, very slowly permeable soils. These soils formed in water-worked clayey till on lake plains. Slopes typically range from 0 to 2 percent.

Viking soils are commonly adjacent to Donaldson, Fargo, Northcote, and Wheatville soils. Donaldson soils are somewhat poorly drained and moderately well drained and are on slightly higher, typically more convex positions. Fargo soils are typically on nearly level lake plains and do not have coarse fragments. Northcote soils are on similar landscapes and formed in lacustrine clay. Wheatville soils are somewhat poorly drained and moderately well drained and are on slightly higher positions.

Typical pedon of Viking sandy clay loam, 100 feet west and 1,640 feet south of the NE corner of sec. 30, T. 138 N., R. 47 W.:

A1—0 to 12 inches; black (10YR 2/1) sandy clay loam; very dark gray (10YR 3/1) dry; medium subangular blocky structure parting to weak very fine granular; very friable; few roots; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

B2g—12 to 21 inches; dark grayish brown (2.5Y 4/2) clay; common fine faint dark yellowish brown (10YR 4/4) and distinct yellowish brown (10YR 5/4) mottles; moderate and strong angular blocky structure; slightly sticky; few roots; darker colors along root channels; 5 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

C1g—21 to 29 inches; grayish brown (2.5Y 5/2) clay; common fine distinct yellowish brown (10YR 5/4) and light yellowish brown (10YR 6/4) mottles; weak and moderate angular blocky structure parting to weak very fine subangular blocky; sticky; 1 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2g—29 to 40 inches; dark grayish brown (2.5Y 4/2) clay; common fine and medium prominent yellowish brown (10YR 5/6 & 5/8) mottles; moderate fine angular blocky structure; very sticky; 1 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C3g—40 to 60 inches; olive gray (5Y 4/2) clay; many medium prominent dark yellowish brown (10YR 4/4) and brownish yellow (10YR 6/6) mottles; moderate fine and medium angular blocky structure; very sticky; 1 percent coarse fragments; strong effervescence; moderately alkaline.

Solum thickness ranges from 20 to 36 inches. The mollic epipedon ranges from 9 to 18 inches in thickness. Reaction is mildly or moderately alkaline throughout. Content of coarse fragments ranges from 1 to 5 percent. Some pedons do not have coarse fragments in the A and upper B horizons.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral and has value of 2. Texture is commonly sandy clay loam, clay loam, or silty clay loam.

The B horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 or 2. It has distinct or prominent mottles. Texture is clay, silty clay, silty clay loam, or clay loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2.

Wahpeton series

The Wahpeton series consists of deep, moderately well drained, moderately permeable or moderately slowly permeable soils. These soils are on lake plains, commonly where terracelike positions are near major streams. They formed in fine textured alluvium. Slope ranges from 0 to 12 percent. These soils are subject to occasional flooding.

Wahpeton soils are commonly adjacent to Cashel and Fargo soils. Cashel soils formed in more recent alluvium and are on lower, frequently flooded positions. Fargo soils have more defined horizonation and are typically on slightly lower areas of broader flats.

Typical pedon of Wahpeton silty clay, 0 to 2 percent slopes, 417 feet north and 2,104 feet east of the SW corner of sec. 30, T. 142 N., R. 49.:

A1—0 to 13 inches; black (10YR 2/1) silty clay; very dark gray (10YR 3/1) dry; moderately strong fine angular blocky structure; friable; sticky; slightly acid; clear wavy boundary broken by tongues of A1 material extending to 24 inches.

B1g—13 to 20 inches; very dark grayish brown (10YR 3/2) silty clay mixed with very dark brown (10YR 2/2); dark gray (10YR 4/1) dry; strong fine angular blocky structure; firm; sticky; neutral; clear smooth boundary.

B2g—20 to 29 inches; very dark grayish brown (10YR 3/2) silty clay mixed with dark grayish brown (10YR 4/2); grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; friable; sticky; slight effervescence; mildly alkaline; clear smooth boundary.

B3g—29 to 34 inches; very dark grayish brown (10YR 3/2) silty clay; gray (10YR 5/1) dry; weak and moderate very fine subangular blocky structure; friable; sticky; slight effervescence; mildly alkaline; clear irregular boundary.

C1—34 to 41 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct light yellowish brown (2.5Y 6/4) and olive yellow (2.5Y 6/6) mottles; weak very fine subangular blocky structure; friable; slightly sticky; few white (10YR 8/1) lime streaks; strongly effervescent; mildly alkaline; clear smooth boundary.

IIAb—41 to 48 inches; very dark gray (10YR 3/1) silty clay; common fine light gray (10YR 7/1) streaks; moderate medium angular blocky structure parting to moderate very fine subangular blocky; friable; sticky; slight effervescence; mildly alkaline; gradual smooth boundary.

IIC2—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay; common fine distinct yellowish brown (10YR 5/6 & 5/8) mottles; massive; sticky; common fine white (10YR 8/1) lime streaks; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 24 to 60 inches in thickness. One or more buried A horizons are separated by a C horizon below a depth of 24 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 through 5, dry), and chroma of 1 or 2, moist or dry. It is clay or silty clay.

The B and C horizons have hue of 10YR, 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or 2. Texture is silty clay, silty clay loam, or clay.

Waukon series

The Waukon series consists of deep, well drained, moderately permeable soils. These soils formed in calcareous loamy glacial till on uplands. Slopes range from 1 to 30 percent.

Waukon soils are commonly adjacent to Darnen, Gonvick, Langhei, and Quam soils. They are similar to and, in places, adjacent to Barnes soils. Darnen soils have a mollic epipedon thicker than 20 inches, are moderately well drained, and are at the base of steeper slopes. Gonvick soils are moderately well drained and are on slightly lower, less sloping areas. Langhei soils are somewhat excessively drained and typically are on slightly higher areas and the break of slopes. Quam soils are very poorly drained and are in partly filled depressions. Barnes soils do not have an argillic horizon and are on similar landscape positions.

Typical pedon of Waukon fine sandy loam, 1 to 6 percent slopes, 1,340 feet north and 1,450 feet east of the SW corner of sec. 11, T. 138 N., R. 44 W.:

Ap—0 to 10 inches; very dark brown (10YR 2/2) fine sandy loam; dark grayish brown (10YR 4/2) dry; weak very fine granular structure; very friable; some bleached sand grains; many roots; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

B2t—10 to 20 inches; dark yellowish brown (10YR 4/4) sandy clay loam; brown (10YR 5/3) dry; dark yellowish brown (10YR 3/4) coatings on peds; strong fine angular blocky structure; friable to firm continuous clay films on peds; many roots; about 2 percent coarse fragments; neutral; clear smooth boundary.

B3—20 to 34 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine and very fine subangular blocky structure; very friable; tongues that have fine angular blocky structure to 30 inches; thin continuous clay films; many roots to 26 inches; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

C1ca—34 to 44 inches; yellowish brown (10YR 5/4) fine sandy loam; few fine prominent brown (7.5YR 5/4) and dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; very friable; common medium white (2.5Y 8/2) lime masses; about 4 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—44 to 60 inches; light yellowish brown (10YR 6/4) fine sandy loam; common fine prominent yellowish red (5YR 5/6) mottles; weak very fine subangular blocky structure; very friable; about 6 percent coarse fragments; many fine light gray (2.5Y 7/2) lime masses; strong effervescence; mildly alkaline.

Thickness of the solum ranges from 18 to 40 inches. The content of coarse fragments ranges from 2 to 8 percent. The Ap or A1 horizon has value of 2 through 3 (3 through 5, dry) and chroma of 1 or 2, moist or dry. Texture is loam, sandy loam, fine sandy loam, silt loam, or light clay loam. Noncultivated sites have an A2 horizon up to 4 inches thick. It has hue of 10YR, value of 3 or 4 (5 or 6, dry), and chroma of 1 or 2.

The B horizon has value of 3 through 5 (5 or 6, dry) and chroma of 3 or 4. Texture is clay loam, sandy clay loam, loam, or sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 through 7, and chroma of 3 or 4. Mottles range from few faint to many prominent. Texture is loam, fine sandy loam, sandy loam, or clay loam. Reaction is mildly or moderately alkaline.

Wheatville series

The Wheatville series consists of deep, somewhat poorly drained and moderately well drained soils. These soils formed dominantly in loamy sediment over clayey sediment on lake plains. They have moderately rapid permeability in the upper sediment and slow permeability in the underlying material. Slopes range from 0 to 6 percent.

Wheatville soils are commonly adjacent to Augsburg, Borup, Elmville, and Glyndon soils. Augsburg and Borup soils are poorly drained and are on slightly lower positions. Elmville soils are on similar positions and have more fine sand in the upper sediment. Glyndon soils are on similar landscape positions and do not have clayey material within 40 inches of the surface.

Typical pedon of Wheatville silt loam, 0 to 2 percent slopes, 520 feet east and 1,620 feet south of the NW corner of section 14, T. 140 N., R. 47 W.:

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam; dark gray (2.5Y 4/1) dry; cloddy parting to weak very fine subangular blocky structure; very friable; many fine roots; violent effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—9 to 15 inches; light brownish gray (10YR 6/2) silt loam; weak very fine subangular blocky structure; very friable; many fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

C2—15 to 23 inches; light yellowish brown (2.5Y 6/3) very fine sandy loam; few fine faint olive yellow (2.5Y 6/6) mottles; weak medium platy structure parting to weak very fine angular blocky; very friable; few fine prominent dark reddish brown (5YR 2/2) concretions; strong effervescence; moderately alkaline; abrupt wavy boundary.

IIC3—23 to 32 inches; olive gray (5Y 5/2) silty clay; common fine faint light yellowish brown (2.5Y 6/3) mottles; moderate very fine subangular blocky structure; sticky; strong effervescence; mildly alkaline; clear wavy boundary.

IIC4—32 to 41 inches; gray (5Y 5/1) silty clay; common fine prominent brown (7.5YR 4/4) and yellowish red (5YR 4/6) mottles; moderate very fine angular blocky structure; sticky; strong effervescence; mildly alkaline; clear smooth boundary.

IIC5—41 to 49 inches; olive gray (5Y 4/2) silty clay; thin light gray (5Y 7/2) silt bands; many medium prominent yellowish brown (10YR 5/6 & 5/8) and brown (7.5YR 4/4) mottles; massive; sticky; strong effervescence; mildly alkaline; gradual smooth boundary.

IIC6—49 to 60 inches; gray (5Y 5/1 & 6/1) silty clay; many medium prominent olive yellow (2.5Y 6/8), brownish yellow (10YR 6/8), and yellowish red (5YR 4/8) mottles; massive; sticky; layered with thin silt loam strata; weak effervescence; mildly alkaline.

The mollic epipedon ranges in thickness from 7 to 14 inches. Depth to the IIC horizon ranges from 20 to 40 inches. Reaction throughout ranges from mildly to moderately alkaline.

The A horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1. Texture is loam, silt loam, sandy clay loam, or very fine sandy loam.

The Cca horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2. Texture is very fine sandy loam, loam, silt loam, sandy clay loam, or loamy very fine sand.

The rest of the C horizon in the upper sediment has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 3 or 4. Mottling ranges from faint to prominent. Texture is loamy very fine sand, very fine sandy loam, silt loam, and loam.

The IIC horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 through 3. Mottling ranges from faint to prominent. Texture is silty clay, clay, or silty clay loam.

Wyndmere series

The Wyndmere series consists of deep, somewhat poorly drained, moderately rapidly permeable soils. These soils formed in calcareous loamy and sandy deposits on lake plains. Slopes range from 0 to 3 percent.

Wyndmere soils are commonly adjacent to Elmville, Glyndon, and Wheatville soils. They are similar to Ulen soils. Elmville soils are on similar landscape positions and have contrasting clayey material within 40 inches of the surface. Glydon and Wheatville soils typically are on similar landscape positions. They have more very fine sand and silt in the profile. Ulen soils are more sandy in the control section and are on less uniform landscapes that have more variation in drainage.

Typical pedon of Wyndmere fine sandy loam, 1,480 feet east and 1,580 feet north of the SW corner of sec. 14, T. 141 N., R. 46 W.:

A1—0 to 10 inches; black (10YR 2/1) fine sandy loam; dark gray (10YR 4/1) dry; weak very fine granular structure; very friable; common fine bleached sand grains; many roots; strong effervescence; moderately alkaline; gradual smooth boundary.

A1ca—10 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam; gray (10YR 5/1) dry; weak medium subangular blocky structure parting to weak very fine subangular blocky; very friable; common very fine bleached sand grains; many roots; strong effervescence; strongly alkaline; gradual smooth boundary.

C1ca—15 to 21 inches; dark grayish brown (10YR 4/2) loamy fine sand; weak medium subangular blocky structure parting to weak very fine subangular blocky; very friable; many roots; violent effervescence; strongly alkaline; clear smooth boundary.

C2ca—21 to 29 inches; grayish brown (10YR 5/2) fine sandy loam; weak very fine subangular blocky structure; very friable; few roots; violent effervescence; strongly alkaline; clear smooth boundary.

C3—29 to 43 inches; pale yellow (2.5Y 7/3) fine sand; few fine distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; single grain; loose; few roots; strong effervescence; strongly alkaline; gradual smooth boundary.

C4—43 to 60 inches; light brownish gray (2.5Y 6/2) very fine sand; common fine prominent olive yellow (2.5Y 6/6), yellowish brown (10YR 5/6), and dark brown (7.5YR 4/4) mottles; single grain; loose; strong effervescence; strongly alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness. The A horizon has value of 2 or 3 (3 through 5, dry) and chroma of 1 or 2, moist or dry. It is fine sandy loam, sandy loam, very fine sandy loam, loam, or loamy very fine sand.

The Cca horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 1 or 2. It has a calcium carbonate content of 10 to 30 percent. In some areas, Wyndmere soils are saline.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 through 7, and chroma of 2 through 4. Mottles range from few to many and from faint to prominent.

Factors of soil formation

Soil results from the action of soil-forming processes on materials deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material accumulated and has existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and resulting drainage conditions, and (5) the length of time that the forces of soil formation have acted on the soil material. These factors of soil formation are interdependent, and few generalizations can be made regarding any one factor unless the effects of the others are known.

Man has influenced the development of soils by disturbing the natural balance of certain factors or altering related conditions. By removing natural vegetation and tilling the soil, he has accelerated erosion. Changes in drainage condition or relief induced by man also may influence soil development. Modification of natural differences by adding fertilizers, using organic residues, or cropping without replacing nutrients also alters the soil-forming processes and resulting soil characteristics.

Parent material

The soils in Clay County formed in calcareous lacustrine deposits, in the basin of glacial Lake Agassiz, and in calcareous glacial till on uplands that have associated areas of alluvium and glacial outwash.

The nearly level, calcareous lacustrine deposits cover approximately two-thirds of the county. These deposits generally are fine textured (clay) in the west and become progressively coarser to the east, grading into silt, very fine sand, and finally sand and gravel where waters were shallow and gently sloping beach ridges are common. Areas of water-modified glacial till also occur in parts of the glacial lake basin.

The eastern one-third of Clay County is on an upland landscape with rather complex relief, in which slopes range from nearly level to very steep. Parent materials in this area were deposited by the Des Moines lobe of the Mankato substage of the Late Wisconsin ice sheet. The dominant material is calcareous gray- and buff-colored glacial till that is mainly loam. Small pebbles and stones are scattered throughout this material. Associated with this area are relatively small areas of outwash, alluvium, and colluvium that range in texture from loam to gravel. Pockets and draws of poorly drained soils are common on this upland landscape. The soils commonly are darker colored, finer textured, or more organic than those in the surrounding better drained areas.

Climate

Climate affects the physical, chemical, and biological characteristics of the soil. Rainfall, humidity, and frost influence the availability of moisture and the rate of percolation. The movement of water dissolves minerals and transports them in the soil mass. Temperature influences formation by regulating the growth of organisms and the speed of chemical reactions.

Clay County has a subhumid, midcontinental climate characterized by wide variations in temperature from summer to winter. The winters are long, and the soil is frozen to a depth of 3 to 5 feet for approximately 6 months of the year. During this time, except for some effects of frost action, the soil-forming processes are largely dormant. The growing season averages 122 days, and during this time the soil receives approximately 60 percent of the annual precipitation. It is during this part of the year that the soil-forming processes influenced by climate are most active. The climate is essentially uniform throughout the county; however, differences in vegetation and relief cause small areas to be influenced by microclimates. Additional information on climate is in the section "General nature of the county."

Plants and animals

All forms of life, both in and on the soil, influence the chemical and biological processes of soil formation. Bacteria, earthworms, and other forms of animal life aid in the weathering of materials and the decomposition of organic matter. Vegetation, including fungi, influences formation by returning residues to the soil and aiding in decomposition. Vegetation is a factor in the transfer of elements in the soil mass, in soil pH, and, in conjunction with climate and relief, the movement of materials by leaching.

The native vegetation in the glacial lake basin was principally tall prairie grasses mixed with wetland reeds and sedges. Fire had some effect on limiting tree growth in this area. Trees have encroached in the eastern part of this basin, and quaking aspen are present in numerous areas. Grasses and sedges that grew over most of the glacial lake basin added large amounts of organic matter to the soils. The encroachment of forest vegetation seems to have had little influence on soil formation in this area. The upland till area in the eastern part of the county, where soils developed under medium and tall prairie grasses, also underwent an encroachment of trees, principally bur oak, red oak, and elm on the well-drained sites. This encroachment also seems to have had little influence. However, on some of the better drained sites, and especially in Parke and Tansem Townships, the leaching of materials gives evidence of development under forest vegetation. Such bottomland hardwoods as ash, basswood, elm, and poplar line the banks and narrow terraces of the major streams in the county. These trees aid in stabilizing these areas, but their other effects on soil formation have been minimal.

The activities of animals on the formation of the soils in the county are of minor importance as compared to the influence of plants. Earthworms and rodents, however, perform an important function in the transportation and translocation of organic materials. Snails and other marine life also influence soil formation because their shells or other skeletal structures increase the carbonate content of the soils. The action of bacteria on soil material and organic matter is an additional important factor in the formation of soil.

Relief

Relief influences soil formation through its effect on drainage, aeration, erosion, and vegetation.

The relief of Clay County is a product of deposits of glacial debris and differential sedimentation in the basin of glacial Lake Agassiz and the beach ridges built up along its old shore lines. The cutting action of streams draining the lake basin, melt waters from the till plain, and the ground moraine left by glacial ice also influenced relief.

The relief of the lake basin is level to nearly level, with many slightly concave areas. This relief commonly results in poorly drained soils that have high organic-matter content and either a gleyed condition or a concentration of carbonates and mottling of varying intensity in the profile. Some of the very sandy and gravelly soils in the eastern part of the lake basin have steeper slope and better drainage.

The influence of relief is more evident on the glacial till upland in the eastern part of the county. On many of the hilltops, knolls, or ridges of this gently sloping to very steep area, the soils have a very thin, dark surface layer or the calcareous gray- and buff-colored parent material is exposed. Accelerated erosion commonly has resulted from rapid runoff, drought, and a lack of protective vegetative cover. Soils downslope from knolls and ridges commonly have a thicker A horizon and a B horizon and, therefore, are deeper to free carbonates. More poorly drained soils in pockets and draws of this area have a development very similar to that of poorly drained soils in the lake basin.

Time

Long periods of time are required for soil to develop; however, the length of time needed for a soil to reach a particular level of development is quite variable. Much less time is required for a soil to form in humid regions that have dense vegetation than in very cold regions that have little vegetation. Drainage also influences how rapidly a soil develops; well-drained sites generally develop more rapidly. The nature of the parent material also determines how quickly development takes place. Soil develops in such materials as glacial till or lacustrine sediment much more rapidly than in residuum of hard bedrock.

Geologically, the soils of Clay County are young. Most of the parent materials were deposited between 9,000 and 12,000 years ago. These materials originated as reworked glacial drift carried by earlier glaciers and underwent considerable weathering prior to being deposited in their present location.

Many soils in the glacial till on the upland landscape of the county have fairly well developed profiles and distinct A, B, and C horizons. Although they developed over nearly the same length of time, soils in the glacial lake plains have less distinct horizons. These soils, however, have dark, highly organic surface layers and commonly have an accumulation of carbonates or a gleyed horizon just below the surface. The differences in development in these areas are basically due to relief and drainage. A few soils on recent alluvial deposits adjacent to major drainageways show little or no profile development.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for Highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) United States Department of Agriculture. 1939. Soil survey of the Red River Valley Area, Minnesota. Bur. Chem. and Soils, Ser. 1932, No. 25. 98 pp., illus.

(3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp., 173-188 issued May 1962]

(4) United States Department of Agriculture. 1960. Engineering handbook. Suppl. a, sec. 4, Hydrol., pp. 3.7-1 to 3.7-3.

(5) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(6) United States Department of Agriculture and Minnesota Department of Agriculture. 1978. Minnesota agricultural statistics. Crop and livestock reporting services.

(7) Upham, Warren. 1969. Minnesota geographic names, their origin and historical significance. Minn. Hist. Soc., Rep. Ed., pp. 114-120, illus.

This page intentionally left blank.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms. The Lco horizon is a limnic layer that contains many fecal pellets.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sulfur (in tables). Excessive amount of sulfur in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake-washed till plain. A till plain that was modified by shallow waters of glacial lake Agassiz. The lake water sorted and levelled the surface till but deposited little or no sediment.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1963-75 at Hawley, Minnesota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	13.9	-6.5	3.7	41	-35	0	.47	.16	.71	2	8.6
February---	21.5	-.7	10.4	46	-32	0	.22	.08	.32	1	3.5
March------	35.3	15.2	25.3	67	-23	63	.78	.37	1.11	2	6.2
April------	53.5	31.9	42.7	81	11	125	2.24	1.28	3.02	5	3.3
May---------	66.6	42.0	54.3	89	23	443	2.68	1.77	3.50	6	.0
June--------	77.5	53.4	65.5	95	37	765	3.92	1.77	5.66	7	.0
July--------	83.6	58.0	70.8	97	42	955	2.88	1.39	4.10	5	.0
August------	81.6	56.0	68.8	97	37	893	3.43	1.27	5.15	5	.0
September--	70.2	45.7	58.0	91	24	540	2.85	.71	4.53	5	.0
October----	58.6	36.2	47.4	84	13	278	1.75	.51	2.75	4	1.3
November---	37.6	20.4	29.0	63	-8	0	.63	.17	1.00	1	2.4
December---	21.9	4.0	13.0	45	-31	0	.76	.43	1.01	3	8.9
Year-----	51.8	29.6	40.7	98	-35	4.062	22.61	18.55	25.23	46	34.2

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1963-75 at Hawley, Minnesota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 9	May 19	May 29
2 years in 10 later than--	May 2	May 15	May 25
5 years in 10 later than--	April 18	May 7	May 16
First freezing temperature in fall:			
1 year in 10 earlier than--	September 26	September 21	September 4
2 years in 10 earlier than--	October 2	September 27	September 10
5 years in 10 earlier than--	October 14	October 7	September 22

TABLE 3.--GROWING SEASON

[Recorded in the period 1963-75 at Hawley, Minnesota]

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	155	133	110
8 years in 10	163	140	116
5 years in 10	178	152	128
2 years in 10	195	165	140
1 year in 10	210	171	147

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
33B	Barnes loam, 1 to 3 percent slopes	8,855	1.3
33B2	Barnes loam, 2 to 6 percent slopes, eroded	20,040	3.0
33C2	Barnes loam, 6 to 12 percent slopes, eroded	1,250	0.2
36	Flom clay loam	780	0.1
38B	Waukon fine sandy loam, 1 to 6 percent slopes	920	0.1
38B2	Waukon loam, 2 to 6 percent slopes, eroded	395	0.1
38C	Waukon fine sandy loam, 6 to 12 percent slopes	1,530	0.2
38C2	Waukon loam, 6 to 12 percent slopes, eroded	1,060	0.2
38D	Waukon fine sandy loam, 12 to 18 percent slopes	685	0.1
38D2	Waukon loam, 12 to 18 percent slopes, eroded	220	*
38E	Waukon fine sandy loam, 18 to 30 percent slopes	345	0.1
45B	Maddock fine sand, 0 to 4 percent slopes	4,530	0.7
45C	Maddock fine sand, 4 to 12 percent slopes	685	0.1
46	Borup loam	13,325	2.0
47	Colvin silty clay loam	39,700	5.8
50	Cashel silty clay	1,255	0.2
52	Augsburg silt loam	15,555	2.3
56	Fargo silty clay loam	1,460	0.2
57A	Fargo silty clay, 0 to 2 percent slopes	47,425	7.0
57B	Fargo silty clay, 2 to 6 percent slopes	265	*
58A	Kittson fine sandy loam, 0 to 2 percent slopes	2,940	0.4
58B	Kittson loam, 1 to 5 percent slopes	2,785	0.4
59	Grimstad fine sandy loam	10,790	1.6
60A	Glyndon loam, 0 to 2 percent slopes	28,105	4.2
60B2	Glyndon loam, 2 to 6 percent slopes, eroded	550	0.1
61	Arveson clay loam	16,615	2.5
63	Rockwell clay loam	2,420	0.4
64	Ulen fine sandy loam	10,705	1.6
65	Foxhome fine sandy loam	905	0.1
66	Flaming fine sand	13,902	2.1
67A	Bearden silt loam, 0 to 2 percent slopes	42,890	6.4
67B2	Bearden silt loam, 2 to 6 percent slopes, eroded	1,640	0.2
68	Arveson clay loam, depressional	1,945	0.3
71	Fossum loamy sand	1,955	0.3
93	Bearden silty clay loam	25,230	3.7
127B	Sverdrup sandy loam, 1 to 4 percent slopes	1,545	0.2
127C	Sverdrup sandy loam, 4 to 12 percent slopes	790	0.1
148	Poppleton fine sand	2,500	0.4
157A	Wahpeton silty clay, 0 to 2 percent slopes	6,075	0.9
157B	Wahpeton silty clay, 2 to 6 percent slopes	1,335	0.2
157C	Wahpeton silty clay, 6 to 12 percent slopes	455	0.1
180B	Gonvick clay loam, 1 to 4 percent slopes	505	0.1
184B	Hamerly loam, 1 to 4 percent slopes	29,265	4.3
236	Vallers loam	11,940	1.8
245B	Lohnes coarse sandy loam, 1 to 6 percent slopes	11,705	1.7
293B	Swenoda sandy loam, 1 to 4 percent slopes	5,600	0.8
335	Urness mucky silt loam	1,225	0.2
343A	Wheatville silt loam, 0 to 2 percent slopes	40,831	6.0
343B2	Wheatville loam, 2 to 6 percent slopes, eroded	385	0.1
344	Quam clay loam	810	0.1
402B	Sioux sandy loam, 1 to 6 percent slopes	10,745	1.6
402C	Sioux sandy loam, 6 to 12 percent slopes	920	0.1
402D	Sioux loamy coarse sand, 12 to 18 percent slopes	740	0.1
402E	Sioux bouldery loamy coarse sand, 12 to 30 percent slopes	860	0.1
403	Viking sandy clay loam	9,895	1.5
413	Osakis loam	2,080	0.3
425	Donaldson fine sandy loam	1,765	0.3
426	Foldahl loamy fine sand	4,110	0.7
429	Northcote clay	6,215	0.9
435	Syrene sandy clay loam	1,865	0.3
494	Darnen loam	3,605	0.5
506	Overly silty clay loam	3,425	0.5
508	Wyndmere fine sandy loam	14,850	2.2
509	Vallers bouldery loam	275	*
510	Elmville fine sandy loam	8,015	1.2
540	Seelyeville muck	1,300	0.2
543	Markey muck	1,770	0.3
544	Cathro muck	620	0.1
545	Rondeau muck	1,915	0.3

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
609	Dickey loamy fine sand	780	0.1
841	Urban land-Fargo complex	2,500	0.4
892B	Sioux-Sverdrup complex, 1 to 6 percent slopes	355	0.1
892C	Sioux-Sverdrup complex, 6 to 18 percent slopes	1,110	0.2
893E	Lohnes-Waukon complex, 12 to 30 percent slopes	1,385	0.2
903B	Barnes-Langhei loams, 1 to 6 percent slopes	34,465	5.0
908	Bearden-Fargo complex	12,090	1.8
935	Hegne-Fargo silty clays	3,190	0.5
942C2	Langhei-Barnes loams, 6 to 12 percent slopes, eroded	31,525	4.6
942D2	Langhei-Barnes loams, 12 to 18 percent slopes, eroded	2,790	0.4
966C	Waukon-Sioux sandy loams, 4 to 12 percent slopes	870	0.1
966D	Waukon-Sioux sandy loams, 12 to 18 percent slopes	365	0.1
967B2	Waukon-Langhei loams, 1 to 6 percent slopes, eroded	980	0.1
979C2	Langhei-Waukon loams, 6 to 12 percent slopes, eroded	4,065	0.6
979D2	Langhei-Waukon loams, 12 to 18 percent slopes, eroded	1,660	0.2
987	Rockwell loam, depressional	205	*
1001	Haplaquolls and Udifluvents, level	4,400	0.7
1005	Fluvaquents, loamy	1,015	0.2
1006	Fluvaquents-Haploborolls complex	2,450	0.4
1029	Pits, gravel	6,645	1.0
1055	Haplaquolls and Histosols, ponded	8,215	1.2
1819	Glyndon silty clay loam	2,100	0.3
1854	Wyndmere complex	2,500	0.4
1871	Fargo silty clay, swales	14,025	2.1
1872	Fargo silty clay, silty substratum	4,510	0.7
1873	Fargo silty clay, silty substratum, swales	1,090	0.2
1874	Lohnes sandy loam	10,445	1.6
1875	Flom clay loam, depressional	580	0.1
1876	Divide loam, loamy substratum	260	*
	Water	3,117	0.5
	Total	673,280	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Spring wheat	Barley	Oats	Sunflower	Sugar beets	Soybeans	Grass-legume hay
	Bu	Bu	Bu	Lb	Ton	Bu	Ton
33B Barnes	45	65	90	1,475	---	32	3.5
33B2 Barnes	43	62	85	1,450	---	29	3.3
33C2 Barnes	36	58	77	1,200	---	23	2.9
36 Flom	40	60	80	1,375	---	28	3.9
38B Waukon	44	65	90	1,475	---	32	3.5
38B2 Waukon	43	61	84	1,450	---	28	3.5
38C Waukon	37	58	76	1,250	---	23	3.2
38C2 Waukon	36	55	74	1,200	---	20	2.9
38D Waukon	30	52	65	---	---	18	2.4
38D2 Waukon	29	49	62	---	---	16	2.1
38E Waukon	18	---	---	---	---	---	1.6
45B Maddock	20	35	47	1,050	---	15	1.5
45C Maddock	17	27	42	950	---	10	1.5
46 Borup	40	61	84	1,400	16	24	3.5
47 Colvin	41	61	82	1,375	17	25	3.5
50 Cashel	34	55	70	1,100	14	20	3.6
52 Augsburg	41	61	83	1,400	17	25	3.6
56, 57A, 57B Fargo	42	66	87	1,425	18	28	3.6
58A Kittson	44	68	90	1,500	---	29	3.5
58B Kittson	43	67	88	1,475	---	27	3.5
59 Grimstad	37	58	80	1,400	---	24	3.2
60A Glyndon	43	64	86	1,480	17	28	3.5

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Oats	Sunflower	Sugar beets	Soybeans	Grass-legume hay
	Bu	Bu	Bu	Lb	Ton	Bu	Ton
60B2 Glyndon	39	60	80	1,450	16	24	3.3
61 Arveson	30	50	65	1,200	---	20	3.2
63 Rockwell	33	52	68	1,250	---	22	3.3
64 Ulen	34	55	75	1,350	---	23	3.0
65 Foxhome	34	54	75	1,375	---	25	3.1
66 Flaming	24	43	59	1,200	---	19	2.5
67A Bearden	44	65	86	1,500	18.3	28	3.8
67B2 Bearden	41	61	80	1,425	17.5	25	3.6
68 Arveson	16	34	50	900	---	10	2.9
71 Fossum	20	37	54	1,000	---	18	3.0
93 Bearden	43	65	84	1,475	18.2	27	4.0
127B Sverdrup	34	54	74	1,250	---	18	2.7
127C Sverdrup	31	50	70	1,175	---	15	2.3
148 Poppleton	21	38	57	1,175	---	17	2.3
157A Wahpeton	45	67	91	1,550	18.2	32	3.8
157B Wahpeton	42	65	88	1,500	17.5	29	3.6
157C Wahpeton	38	57	78	1,375	---	22	3.0
180B Gonvick	43	65	88	1,475	---	30	3.9
184B Hamerly	38	61	82	1,450	---	25	3.8
236 Vallers	35	58	80	1,325	---	23	3.8
245B Lohnes	16	26	40	950	---	11	1.4
293B Swenoda	37	60	84	1,450	---	25	3.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Oats	Sunflower	Sugar beets	Soybeans	Grass-legume hay
	Bu	Bu	Bu	Lb	Ton	Bu	Ton
335----------------------- Urness	18	40	60	800	---	---	3.2
343A---------------------- Wheatville	44	64	86	1,500	17.5	28	3.7
343B2--------------------- Wheatville	40	60	81	1,450	16.8	25	3.4
344----------------------- Quam	30	55	71	1,180	---	23	4.0
402B---------------------- Sioux	15	24	36	890	---	9	1.3
402C, 402D, 402E. Sioux							
403----------------------- Viking	41	63	82	1,400	16.5	26	3.5
413----------------------- Osakis	33	52	72	1,350	---	23	2.8
425----------------------- Donaldson	43	63	86	1,500	16.8	31	3.6
426----------------------- Foldahl	31	51	77	1,285	---	21	3.0
429----------------------- Northcote	40	61	80	1,380	16.0	25	3.5
435----------------------- Syrene	30	50	64	1,200	---	21	3.2
494----------------------- Darnen	44	66	88	1,500	---	30	3.9
506----------------------- Overly	46	68	92	1,575	18.5	34	3.7
508----------------------- Wyndmere	40	61	81	1,450	15.8	25	3.1
509. Vallers							
510----------------------- Elmville	42	63	84	1,450	16.5	26	3.3
540----------------------- Seelyeville	11	22	35	---	---	---	2.5
543----------------------- Markey	13	23	36	---	---	---	2.5
544----------------------- Cathro	15	28	44	---	---	---	2.8
545----------------------- Rondeau	12	22	37	---	---	---	2.5
609----------------------- Dickey	21	36	54	1,180	---	17	2.0
841. Urban land-Fargo							

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Oats	Sunflower	Sugar beets	Soybeans	Grass-legume hay
	Bu	Bu	Bu	Lb	Ton	Bu	Ton
892B. Sioux-Sverdrup	18	34	50	1,150	---	16	1.8
892C. Sioux-Sverdrup	16	32	47	1,080	---	12	1.5
893E. Lohnes-Waukon	11	23	35	---	---	---	1.0
903B. Barnes-Langhei	41	60	83	1,425	---	27	3.2
908. Bearden-Fargo	43	63	84	1,450	17.6	27	3.9
935. Hegne-Fargo	41	59	80	1,375	17	25	3.8
942C2. Langhei-Barnes	34	54	75	1,175	---	20	2.5
942D2. Langhei-Barnes	28	49	60	---	---	15	1.5
966C. Waukon-Sioux	28	49	64	1,200	---	16	1.8
966D. Waukon-Sioux	21	45	60	---	---	---	1.5
967B2. Waukon-Langhei	40	60	82	1,425	---	27	3.2
979C2. Langhei-Waukon	33	53	73	1,175	---	21	2.5
979D2. Langhei-Waukon	28	47	59	---	---	14	1.9
987. Rockwell	19	35	54	900	---	11	3.0
1001. Haplaquolls and Udifluvents	34	56	71	1,100	---	21	3.6
1005. Fluvaquents							
1006. Fluvaquents-Haploborolls							
1029. Pits							
1055. Haplaquolls and Histosols							
1819. Glyndon	43	64	85	1,475	17	28	3.7
1854. Wyndmere	30	49	57	1,100	14	14	2.5
1871. Fargo	39	60	80	1,175	15	22	35
1872. Fargo	43	67	87	1,425	18.2	28	3.6

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Oats	Sunflower	Sugar beets	Soybeans	Grass-legume hay
	Bu	Bu	Bu	Lb	Ton	Bu	Ton
1873------------------------ Fargo	40	61	80	1,175	16	22	3.5
1874------------------------ Lohnes	21	38	54	1,175	---	19	1.6
1875------------------------ Flom	22	40	60	950	---	---	3.4
1876------------------------ Divide	33	54	74	1,325	---	22	3.0

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
33B, 33B2, 33C2---Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash	Siberian elm.
36---Flom	Lilac, silver buffaloberry.	Siberian peashrub, tall purple willow, Tatarian honeysuckle.	Common hackberry, ponderosa pine, blue spruce, Siberian crabapple.	Golden willow, green ash.	Eastern cottonwood.
38B, 38B2, 38C, 38C2, 38D, 38D2, 38E---Waukon	---	Lilac	Eastern redcedar, blue spruce, northern white-cedar, white spruce, bur oak, Amur maple, Siberian crabapple.	Eastern white pine, green ash, red pine, common hackberry.	---
45B, 45C---Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
46---Borup	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Black Hills spruce, Siberian crabapple, common hackberry, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
47---Colvin	---	Tatarian honeysuckle, Siberian peashrub, common chokecherry, lilac.	Siberian crabapple, Black Hills spruce, eastern redcedar, blue spruce.	Green ash, golden willow.	Eastern cottonwood, Siberian elm.
50---Cashel	---	Redosier dogwood, ponderosa pine, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
52. Augsburg	---	Redosier dogwood, common chokecherry, Tatarian honeysuckle, Siberian peashrub, American plum, eastern redcedar, lilac.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
56, 57A, 57B. Fargo	---	Common chokecherry, eastern redcedar, American plum, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm, green ash.	Eastern cottonwood.
58A, 58B. Kittson	---	American plum, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, ponderosa pine, Siberian crabapple.	Green ash, common hackberry, golden willow.	Eastern cottonwood, Siberian elm.
59. Grimstad	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, Siberian crabapple, ponderosa pine.	Green ash, golden willow, common hackberry.	Eastern cottonwood, Siberian elm.
60A, 60B2. Glyndon	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, Siberian crabapple, ponderosa pine.	Green ash, golden willow, common hackberry.	Eastern cottonwood, Siberian elm.
61. Arveson	Lilac, silver buffaloberry.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Siberian crabapple, eastern redcedar, Black Hills spruce, common hackberry.	Golden willow, green ash.	Eastern cottonwood.
63. Rockwell	Lilac, silver buffaloberry.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Siberian crabapple, eastern redcedar, Black Hills spruce, common hackberry.	Golden willow, green ash.	Eastern cottonwood.
64. Ulen	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, American plum, lilac.	Siberian crabapple, common hackberry, Russian-olive, white spruce, green ash.	Siberian elm	Eastern cottonwood.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
65. Foxhome	---	Ponderosa pine, common chokecherry, eastern redcedar, Siberian peashrub, Tatarian honeysuckle, American plum, redosier dogwood, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
66. Flaming	---	Eastern redcedar, common chokecherry, Siberian crabapple, American plum, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle, lilac.	Russian-olive, ponderosa pine, bur oak, green ash.	---	---
67A, 67B2. Bearden	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
68. Arveson	Silver buffaloberry, lilac.	Siberian peashrub, Tatarian honeysuckle.	Black Hills spruce, Siberian crabapple, common hackberry, eastern redcedar, ponderosa pine.	Golden willow, green ash.	Eastern cottonwood.
71. Fossum	Lilac, silver buffaloberry.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Siberian crabapple, eastern redcedar, Black Hills spruce.	Green ash, golden willow, common hackberry.	Eastern cottonwood.
93. Bearden	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
127B, 127C. Sverdrup	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, American plum, lilac.	Siberian crabapple, common hackberry, Russian-olive, ponderosa pine, green ash.	Siberian elm	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
148 Poppleton	---	Eastern redcedar, bur oak, common chokecherry, American plum, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, lilac, Siberian peashrub.	Ponderosa pine, green ash, Russian-olive.	---	---
157A, 157B, 157C Wahpeton	---	Peking cotoneaster, ponderosa pine, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
180B Gonvick	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, white spruce, Amur maple, eastern redcedar.	Green ash, common hackberry, eastern white pine.	Eastern cottonwood.
184B Hamerly	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
236 Vallers	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, common hackberry, Siberian crabapple, Black Hills spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
245B. Lohnes					
293B Swenoda	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, lilac, American plum.	Green ash, common hackberry, ponderosa pine, Russian-olive, Siberian crabapple.	Siberian elm	---
335 Urness	---	Tatarian honeysuckle.	Tall purple willow.	Golden willow	Carolina poplar.
343A, 343B2 Wheatville	---	Ponderosa pine, common chokecherry, eastern redcedar, Siberian peashrub, Tatarian honeysuckle, American plum, redosier dogwood, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
344 Quam	Lilac, silver buffaloberry.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
402B, 402C, 402D, 402E. Sioux					
403 Viking	---	Common chokecherry, redosier dogwood, Tatarian honeysuckle, American plum, Siberian peashrub, eastern redcedar, lilac.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
413 Osakis	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, American plum, lilac.	Siberian crabapple, common hackberry, Russian-olive, ponderosa pine, green ash.	Siberian elm	---
425 Donaldson	---	Siberian peashrub, eastern redcedar, Tatarian honeysuckle, ponderosa pine, common chokecherry, American plum, redosier dogwood, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
426 Foldahl	---	Eastern redcedar, American plum, common chokecherry, Siberian crabapple, Tatarian honeysuckle, lilac, Siberian peashrub, silver buffaloberry.	Ponderosa pine, green ash, bur oak.	---	---
429 Northcote	---	Eastern redcedar, common chokecherry, redosier dogwood, Tatarian honeysuckle, lilac, American plum, Siberian peashrub.	Black Hills spruce, green ash, Siberian crabapple.	Golden willow	Eastern cottonwood.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
435----------------- Syrene	---	Common chokecherry, Siberian peashrub, American plum, redosier dogwood, Tatarian honeysuckle, eastern redcedar, lilac.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow-----	Eastern cottonwood.
494----------------- Darnen	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, Siberian crabapple, ponderosa pine.	Green ash, golden willow, common hackberry.	Eastern cottonwood, Siberian elm.
506----------------- Overly	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
508----------------- Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Tatarian honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
509----------------- Vallers	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, common hackberry, Siberian crabapple, Black Hills spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
510----------------- Elmville	---	Ponderosa pine, common chokecherry, eastern redcedar, Siberian peashrub, Tatarian honeysuckle, American plum, redosier dogwood, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
540----------------- Seelyeville	---	Tatarian honeysuckle.	Tall purple willow.	Golden willow-----	Carolina poplar.
543----------------- Markey	---	Tatarian honeysuckle.	Tall purple willow.	Golden willow-----	Carolina poplar.
544----------------- Cathro	---	Tatarian honeysuckle.	Tall purple willow.	Golden willow-----	Carolina poplar.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
545: Rondeau	---	Tatarian honeysuckle.	Tall purple willow.	Golden willow	Carolina poplar.
609: Dickey	---	Eastern redcedar, lilac, Siberian peashrub.	Green ash, Siberian crabapple, common hackberry.	Siberian elm	---
841*: Urban land.					
Fargo	---	Common chokecherry, eastern redcedar, American plum, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm, green ash.	Eastern cottonwood.
892B*, 892C*: Sioux.					
Sverdrup	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, American plum, lilac.	Siberian crabapple, common hackberry, Russian-olive, ponderosa pine, green ash.	Siberian elm	---
893E*: Lohnes.					
Waukon.					
903B*: Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash	Siberian elm.
Langhei	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, Russian-olive, common hackberry, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash.	---	---
908*: Bearden	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
908*:					
Fargo	---	Common chokecherry, eastern redcedar, American plum, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm, green ash.	Eastern cottonwood.
935*:					
Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Fargo	---	Common chokecherry, eastern redcedar, American plum, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm, green ash.	Eastern cottonwood.
942C2*, 942D2*:					
Langhei	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, Russian-olive, common hackberry, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash.	---	---
Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash	Siberian elm.
966C*, 966D*:					
Waukon	---	Lilac	Eastern redcedar, blue spruce, northern white-cedar, white spruce, bur oak, Amur maple, Siberian crabapple.	Eastern white pine, green ash, red pine, common hackberry.	---
Sioux.					
967B2*:					
Waukon	---	Lilac	Eastern redcedar, blue spruce, northern white-cedar, white spruce, bur oak, Amur maple, Siberian crabapple.	Eastern white pine, green ash, red pine, common hackberry.	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
967B2*:					
Langhei	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, Russian-olive, common hackberry, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash.	---	---
979C2*, 979D2*:					
Langhei	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, Russian-olive, common hackberry, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash.	---	---
Waukon	---	Lilac	Eastern redcedar, blue spruce, northern white-cedar, white spruce, bur oak, Amur maple, Siberian crabapple.	Eastern white pine, green ash, red pine, common hackberry.	---
987 Rockwell	---	Tatarian honeysuckle, eastern redcedar, American plum, common chokecherry, Siberian peashrub, redosier dogwood, lilac.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
1001*:					
Haplaquolls.					
Udifluvents.					
1005*. Fluvaquents					
1006*:					
Fluvaquents.					
Haploborolls.					
1029*. Pits					
1055*:					
Haplaquolls.					
Histosols.					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1819-------------- Glyndon	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, Siberian crabapple, ponderosa pine.	Green ash, golden willow, common hackberry.	Eastern cottonwood, Siberian elm.
1854*: Wyndmere, saline.					
Wyndmere---------	---	Redosier dogwood, ponderosa pine, American plum, Tatarian honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
1871-------------- Fargo	---	Common chokecherry, eastern redcedar, American plum, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm, green ash.	Eastern cottonwood.
1872-------------- Fargo	---	Common chokecherry, Tatarian honeysuckle, American plum, Siberian peashrub, eastern redcedar, lilac, redosier dogwood.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
1873-------------- Fargo	---	Common chokecherry, American plum, Siberian peashrub, eastern redcedar, lilac, redosier dogwood.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
1874. Lohnes					
1875-------------- Flom	---	Common chokecherry, Tatarian honeysuckle, American plum, Siberian peashrub, eastern redcedar, lilac, redosier dogwood.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
1876-------------- Divide	---	Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
33B, 33B2 Barnes	Slight	Slight	Moderate: slope.	Slight	Slight.
33C2 Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
36 Flom	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: excess humus, wetness.	Moderate: wetness.	Moderate: wetness.
38B, 38B2 Waukon	Slight	Slight	Moderate: slope.	Slight	Slight.
38C, 38C2 Waukon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
38D, 38D2, 38E Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
45B Maddock	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
45C Maddock	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
46 Borup	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
47 Colvin	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
50 Cashel	Severe: floods, wetness.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
52 Augsburg	Severe: floods, wetness, percs slowly.	Severe: percs slowly.	Severe: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
56 Fargo	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
57A, 57B Fargo	Severe: floods, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
58A Kittson	Slight	Slight	Slight	Slight	Slight.
58B Kittson	Slight	Slight	Moderate: slope.	Slight	Slight.
59 Grimstad	Slight	Slight	Slight	Slight	Slight.
60A Glyndon	Slight	Slight	Slight	Slight	Slight.
60B2 Glyndon	Slight	Slight	Moderate: slope.	Slight	Slight.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
61: Arveson	Severe: floods, wetness, excess humus.	Severe: excess humus.	Severe: excess humus, wetness.	Severe: excess humus.	Moderate: wetness.
63: Rockwell	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
64: Ulen	Severe: floods.	Slight	Slight	Slight	Slight.
65: Foxhome	Slight	Slight	Slight	Slight	Slight.
66: Flaming	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty.
67A, 67B2: Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
68: Arveson	Severe: floods, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
71: Fossum	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
93: Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
127B: Sverdrup	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
127C: Sverdrup	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
148: Poppleton	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty.
157A: Wahpeton	Severe: floods.	Moderate: too clayey.	Moderate: too clayey, floods.	Moderate: too clayey.	Severe: too clayey.
157B: Wahpeton	Severe: floods.	Moderate: too clayey.	Moderate: slope, too clayey, floods.	Moderate: too clayey.	Severe: too clayey.
157C: Wahpeton	Severe: floods.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.	Severe: too clayey.
180B: Gonvick	Slight	Slight	Moderate: slope.	Slight	Slight.
184B: Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight	Slight.
236: Vallers	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
245B: Lohnes	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
293B: Swenoda	Slight	Slight	Moderate: slope.	Slight	Slight.
335: Urness	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding
343A: Wheatville	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight	Slight.
343B2: Wheatville	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
344: Quam	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
402B: Sioux	Slight	Slight	Moderate: slope, small stones.	Slight	Severe: droughty.
402C: Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
402D: Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: droughty, slope.
402E: Sioux	Severe: slope.	Severe: slope.	Severe: large stones, slope, small stones.	Severe: large stones.	Severe: large stones, droughty, slope.
403: Viking	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
413: Osakis	Slight	Slight	Slight	Slight	Moderate: droughty.
425: Donaldson	Slight	Slight	Slight	Slight	Slight.
426: Foldahl	Slight	Slight	Slight	Slight	Moderate: droughty.
429: Northcote	Severe: floods, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
435: Syrene	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
494: Darnen	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Slight.
506: Overly	Slight	Slight	Slight	Slight	Slight.
508: Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
509 Vallers	Severe: wetness.	Severe: excess humus.	Severe: large stones, excess humus, wetness.	Severe: excess humus.	Moderate: large stones, wetness.
510 Elmville	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight	Slight.
540 Seelyeville	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
543 Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
544 Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
545 Rondeau	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
609 Dickey	Slight	Slight	Slight	Slight	Moderate: droughty.
841*: Urban land.					
Fargo	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
892B*: Sioux	Slight	Slight	Moderate: slope, small stones.	Slight	Severe: droughty.
Sverdrup	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
892C*: Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
Sverdrup	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
893E*: Lohnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
903B*: Barnes	Slight	Slight	Moderate: slope.	Slight	Slight.
Langhei	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
908*:					
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
Fargo	Severe: floods, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
935*:					
Hegne	Severe: floods, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
Fargo	Severe: floods, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
942C2*:					
Langhei	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
942D2*:					
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
966C*:					
Waukon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
966D*:					
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: droughty, slope.
967B2*:					
Waukon	Slight	Slight	Moderate: slope.	Slight	Slight.
Langhei	Slight	Slight	Moderate: slope.	Slight	Slight.
979C2*:					
Langhei	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Waukon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
979D2*:					
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
979D2*:					
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
987 Rockwell	Severe: floods, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
1001*: Haplaquolls					
Udifluvents.					
1005*. Fluvaquents.					
1006*: Fluvaquents.					
Haploborolls.					
1029*. Pits					
1055*: Haplaquolls.					
Histosols.					
1819 Glyndon	Slight	Slight	Slight	Slight	Slight.
1854*:					
Wyndmere, saline	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight	Severe: excess salt.
Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
1871 Fargo	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.	Severe: ponding, too clayey.
1872 Fargo	Severe: too clayey, wetness, floods.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
1873 Fargo	Severe: floods, ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.	Severe: ponding, too clayey.
1874 Lohnes	Slight	Slight	Slight	Slight	Moderate: droughty.
1875 Flom	Severe: floods, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
1876 Divide	Slight	Slight	Slight	Slight	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
33B, 33B2---------- Barnes	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
33C2--------------- Barnes	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
36----------------- Flom	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
38B, 38B2---------- Waukon	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
38C, 38C2---------- Waukon	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
38D, 38D2---------- Waukon	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
38E---------------- Waukon	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
45B---------------- Maddock	Fair	Good	Good	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
45C---------------- Maddock	Poor	Fair	Good	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
46----------------- Borup	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
47----------------- Colvin	Good	Good	---	Fair	Fair	Good	Good	Good	Fair	Good.
50----------------- Cashel	Good	Good	Fair	---	---	Poor	Fair	Good	---	Poor.
52----------------- Augsburg	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
56----------------- Fargo	Good	Good	Fair	---	---	Good	Good	Fair	---	Good.
57A, 57B----------- Fargo	Good	Good	Fair	---	---	Poor	Fair	Fair	---	Poor.
58A, 58B----------- Kittson	Good	Good	Good	Fair	Fair	Fair	Poor	Good	Fair	Fair.
59----------------- Grimstad	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
60A, 60B2---------- Glyndon	Good	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Poor.
61----------------- Arveson	Good	Good	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
63----------------- Rockwell	Fair	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
64----------------- Ulen	Fair	Good	Good	Fair	Poor	Poor	Poor	Fair	Fair	Poor.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
65: Foxhome	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor.
66: Flaming	Fair	Fair	Good	Fair	Fair	Fair	Poor	Fair	Fair	Fair.
67A, 67B2: Bearden	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
68: Arveson	Fair	Fair	Poor	Fair	Fair	Good	Good	Fair	Fair	Good.
71: Fossum	Poor	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
93: Bearden	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
127B: Sverdrup	Fair	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Poor.
127C: Sverdrup	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
148: Poppleton	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
157A: Wahpeton	Good	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
157B: Wahpeton	Good	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
157C: Wahpeton	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
180B: Gonvick	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
184B: Hamerly	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
236: Vallers	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
245B: Lohnes	Fair	Good	Good	Poor	Poor	Poor	Very poor.	Good	Poor	Very poor.
293B: Swenoda	Fair	Fair	Fair	Good	Very poor.	Very poor.	Very poor.	Fair	Good	Very poor.
335: Urness	Poor	Poor	Poor	Poor	Very poor.	Poor	Poor	Poor	Poor	Poor.
343A, 343B2: Wheatville	Good	Good	Good	Fair	Poor	Poor	Fair	Good	Fair	Fair.
344: Quam	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
402B: Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
402C, 402D, 402E: Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
403-----------------Viking	Poor	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
413-----------------Osakis	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
425-----------------Donaldson	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor.
426-----------------Foldahl	Fair	Good	Good	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
429-----------------Northcote	Fair	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor	Fair.
435-----------------Syrene	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
494-----------------Darnen	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
506-----------------Overly	Good	Good	Good	Good	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
508-----------------Wyndmere	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
509-----------------Vallers	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
510-----------------Elmville	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
540-----------------Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
543-----------------Markey	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Fair.
544-----------------Cathro	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good.
545-----------------Rondeau	Fair	Fair	Poor	Poor	Very poor.	Good	Good	Fair	Very poor.	Good.
609-----------------Dickey	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
841*: Urban land.										
Fargo---------------	Good	Good	Fair	---	---	Poor	Good	Fair	---	Fair.
892B*: Sioux---------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Sverdrup-----------	Fair	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Poor.
892C*: Sioux---------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Sverdrup-----------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
893E*:										
Lohnes------------	Poor	Fair	Good	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Waukon------------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
903B*:										
Barnes------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Langhei-----------	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
908*:										
Bearden-----------	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Fargo-------------	Good	Good	Fair	---	---	Poor	Fair	Fair	---	Poor.
935*:										
Hegne-------------	Fair	Fair	Fair	Fair	Poor	Poor	Good	Fair	Fair	Fair.
Fargo-------------	Good	Good	Fair	---	---	Poor	Fair	Fair	---	Poor.
942C2*:										
Langhei-----------	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Barnes------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
942D2*:										
Langhei-----------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Barnes------------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
966C*:										
Waukon------------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sioux-------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
966D*:										
Waukon------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Sioux-------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
967B2*:										
Waukon------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Langhei-----------	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
979C2*:										
Langhei-----------	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Waukon------------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
979D2*:										
Langhei	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Waukon	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
987 Rockwell	Fair	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
1001*:										
Haplaquolls.										
Udifluvents.										
1005*. Fluvaquents										
1006*:										
Fluvaquents.										
Haploborolls.										
1029*. Pits										
1055*:										
Haplaquolls.										
Histosols.										
1819 Glyndon	Good	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Poor.
1854*:										
Wyndmere, saline	Fair	Fair	Good	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
Wyndmere	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
1871 Fargo	Very poor.	Poor	Fair	---	---	Poor	Good	Poor	---	Fair.
1872 Fargo	Good	Good	Fair	Fair	---	Poor	Good	Fair	---	Fair.
1873 Fargo	Very poor.	Poor	Fair	---	---	Poor	Good	Poor	---	Fair.
1874 Lohnes	Fair	Good	Good	Poor	Poor	Poor	Very poor.	Good	Poor	Very poor.
1875 Flom	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
1876 Divide	Fair	Fair	Good	Good	Good	Fair	Very poor.	Fair	Good	Poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
33B, 33B2 Barnes	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
33C2 Barnes	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
36 Flom	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
38B Waukon	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.	Slight.
38B2 Waukon	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Slight.
38C, 38C2 Waukon	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action, shrink-swell.	Moderate: slope.
38D, 38D2, 38E Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
45B Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
45C Maddock	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
46 Borup	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
47 Colvin	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: low strength, wetness, frost action.	Severe: wetness.
50 Cashel	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: low strength, floods.	Severe: too clayey.
52 Augsburg	Severe: wetness.	Severe: floods, wetness.	Severe: wetness, floods, shrink-swell.	Severe: floods, wetness.	Severe: frost action.	Moderate: wetness.
56 Fargo	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness.	Severe: wetness.
57A, 57B Fargo	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness.	Severe: wetness, too clayey.
58A, 58B Kittson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action.	Slight.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
59----------------- Grimstad	Moderate: cutbanks cave, wetness.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.	Slight.
60A, 60B2---------- Glyndon	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Severe: frost action.	Slight.
61----------------- Arveson	Severe: cutbanks cave, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: frost action.	Moderate: wetness.
63----------------- Rockwell	Severe: cutbanks cave, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: frost action.	Moderate: wetness.
64----------------- Ulen	Severe: cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, frost action.	Slight.
65----------------- Foxhome	Moderate: wetness.	Slight----------	Moderate: wetness.	Slight----------	Severe: frost action.	Slight.
66----------------- Flaming	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.	Moderate: droughty.
67A, 67B2---------- Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
68----------------- Arveson	Severe: cutbanks cave, ponding.	Severe: floods, ponding.	Severe: floods, ponding.	Severe: floods, ponding.	Severe: ponding, frost action.	Severe: ponding.
71----------------- Fossum	Severe: wetness, cutbanks cave.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Moderate: wetness, floods, frost action.	Moderate: wetness, droughty.
93----------------- Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
127B--------------- Sverdrup	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty.
127C--------------- Sverdrup	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
148---------------- Poppleton	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.	Moderate: droughty.
157A, 157B--------- Wahpeton	Moderate: too clayey, floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, floods, frost action.	Severe: too clayey.
157C--------------- Wahpeton	Moderate: too clayey, floods, slope.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell, slope.	Severe: low strength, floods, frost action.	Severe: too clayey.
180B--------------- Gonvick	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: frost action.	Slight.
184B--------------- Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
236---------------- Vallers	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: frost action.	Moderate: wetness.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
245B: Lohnes	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
293B: Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.	Slight.
335: Urness	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
343A: Wheatville	Moderate: too clayey, wetness.	Slight	Severe: shrink-swell.	Slight	Severe: frost action.	Slight.
343B2: Wheatville	Moderate: too clayey, wetness.	Slight	Severe: shrink-swell.	Moderate: slope.	Severe: frost action.	Slight.
344: Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
402B: Sioux	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
402C: Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
402D: Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
402E: Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: large stones, droughty, slope.
403: Viking	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
413: Osakis	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Moderate: droughty.
425: Donaldson	Severe: cutbanks cave.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
426: Foldahl	Severe: cutbanks cave.	Slight	Moderate: shrink-swell, wetness.	Slight	Severe: frost action.	Moderate: droughty.
429: Northcote	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: frost action, shrink-swell, low strength.	Severe: too clayey.
435: Syrene	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness.
494: Darnen	Severe: excess humus.	Severe: low strength.	Moderate: wetness, shrink-swell.	Severe: low strength.	Moderate: frost action.	Slight.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
506---------------- Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
508---------------- Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
509---------------- Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: large stones, wetness.
510---------------- Elmville	Severe: cutbanks cave.	Slight---------	Moderate: wetness, shrink-swell.	Slight---------	Severe: frost action.	Slight.
540---------------- Seelyeville	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
543---------------- Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
544---------------- Cathro	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
545---------------- Rondeau	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
609---------------- Dickey	Severe: cutbanks cave.	Slight---------	Moderate: shrink-swell.	Slight---------	Slight---------	Moderate: droughty.
841*: Urban land.						
Fargo-------------	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness.	Severe: wetness, too clayey.
892B*: Sioux-------------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
Sverdrup----------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
892C*: Sioux-------------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
Sverdrup----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
893E*: Lohnes------------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, droughty.
Waukon------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
903B*: Barnes------------	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Slight.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
903B*:						
Langhei	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
908*:						
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
Fargo	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness.	Severe: wetness, too clayey.
935*:						
Hegne	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
Fargo	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness.	Severe: wetness, too clayey.
942C2*:						
Langhei	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Barnes	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
942D2*:						
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
966C*:						
Waukon	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action, shrink-swell.	Moderate: slope.
Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
966D*:						
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
967B2*:						
Waukon	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.	Slight.
Langhei	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
979C2*:						
Langhei----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Waukon-----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action, shrink-swell.	Moderate: slope.
979D2*:						
Langhei----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Waukon-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
987--------------- Rockwell	Severe: cutbanks cave, ponding.	Severe: floods, ponding.	Severe: floods, ponding.	Severe: floods, ponding.	Severe: ponding, frost action.	Severe: ponding.
1001*:						
Haplaquolls.						
Udifluvents.						
1005*. Fluvaquents						
1006*:						
Fluvaquents.						
Haploborolls.						
1029*. Pits						
1055*:						
Haplaquolls.						
Histosols.						
1819-------------- Glyndon	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
1854*:						
Wyndmere, saline	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Severe: excess salt.
Wyndmere---------	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
1871-------------- Fargo	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding, too clayey.
1872-------------- Fargo	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
1873-------------- Fargo	Severe: ponding.	Severe: floods, ponding, shrink-swell.	Severe: floods, ponding.	Severe: floods, ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding, too clayey.
1874-------------- Lohnes	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1875: Flom	Severe: ponding.	Severe: floods, ponding.	Severe: floods, ponding.	Severe: floods, ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1876: Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
33B, 33B2 Barnes	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
33C2 Barnes	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
36 Flom	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
38B Waukon	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
38B2 Waukon	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
38C, 38C2 Waukon	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
38D, 38D2, 38E Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
45B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
45C Maddock	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
46 Borup	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: wetness.
47 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
50 Cashel	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: too clayey, hard to pack.
52 Augsburg	Severe: wetness, percs slowly.	Severe: seepage, floods, wetness.	Severe: wetness, too clayey.	Severe: wetness, seepage.	Poor: wetness, too clayey, hard to pack.
56, 57A, 57B Fargo	Severe: wetness, percs slowly.	Severe: floods, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
58A, 58B Kittson	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
59: Grimstad	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
60A, 60B2: Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
61: Arveson	Severe: wetness, poor filter.	Severe: seepage, floods, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
63: Rockwell	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
64: Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
65: Foxhome	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
66: Flaming	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
67A, 67B2: Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
68: Arveson	Severe: ponding, poor filter.	Severe: seepage, floods, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
71: Fossum	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: seepage, too sandy, wetness.
93: Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
127B: Sverdrup	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
127C: Sverdrup	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
148: Poppleton	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
157A, 157B: Wahpeton	Severe: floods, percs slowly.	Severe: floods.	Severe: floods, too clayey.	Severe: floods.	Poor: too clayey, hard to pack.
157C: Wahpeton	Severe: floods, percs slowly.	Severe: floods, slope.	Severe: floods, too clayey.	Severe: floods.	Poor: too clayey, hard to pack.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
180B----------------- Gonvick	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
184B----------------- Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
236------------------ Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
245B----------------- Lohnes	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
293B----------------- Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
335------------------ Urness	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
343A, 343B2---------- Wheatville	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness, too clayey.	Severe: seepage, wetness.	Poor: too clayey, hard to pack.
344------------------ Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
402B----------------- Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
402C----------------- Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
402D----------------- Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
402E----------------- Sioux	Severe: poor filter, slope.	Severe: seepage, slope, large stones.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
403------------------ Viking	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
413------------------ Osakis	Severe: poor filter.	Severe: seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
425------------------ Donaldson	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness, too clayey.	Severe: wetness, seepage.	Poor: too clayey, hard to pack.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
426: Foldahl	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: small stones, wetness.
429: Northcote	Severe: wetness, percs slowly.	Severe: floods, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness, too clayey, hard to pack.
435: Syrene	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: seepage, too sandy, wetness.
494: Darnen	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
506: Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
508: Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
509: Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
510: Elmville	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness, too clayey.	Severe: seepage, wetness.	Poor: too clayey, hard to pack.
540: Seelyeville	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
543: Markey	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
544: Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
545: Rondeau	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
509: Dickey	Severe: percs slowly, poor filter.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
341*: Urban land.					
Fargo	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
892B*:					
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Sverdrup	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
892C*:					
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Sverdrup	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
893E*:					
Lohnes	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
903B*:					
Barnes	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Langhei	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
908*:					
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Fargo	Severe: wetness, percs slowly.	Severe: floods, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
935*:					
Hegne	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Fargo	Severe: wetness, percs slowly.	Severe: floods, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
942C2*:					
Langhei	Moderate: percs slowly, slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Barnes	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
942D2*:					
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
966C*:					
Waukon	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
966D*:					
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
967B2*:					
Waukon	Moderate: percs slowly.	Moderate: seepage, slope, excess humus.	Moderate: too clayey.	Slight	Fair: too clayey.
Langhei	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
979C2*:					
Langhei	Moderate: percs slowly, slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Waukon	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
979D2*:					
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
987 Rockwell	Severe: ponding, percs slowly, poor filter.	Severe: seepage, floods, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
1001*:					
Haplaquolls.					
Udifluvents.					
1005*. Fluvaquents					
1006*: Fluvaquents.					

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1006*: Haploborolls.					
1029*. Pits					
1055*: Haplaquolls.					
Histosols.					
1819 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
1854*: Wyndmere, saline	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
1871 Fargo	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Severe: too clayey, hard to pack, ponding.
1872 Fargo	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1873 Fargo	Severe: ponding, percs slowly.	Severe: floods, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1874 Lohnes	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
1875 Flom	Severe: ponding, percs slowly.	Severe: floods, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1876 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
33B, 33B2 Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
33C2 Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
36 Flom	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
38B, 38B2 Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
38C, 38C2 Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
38D, 38D2, 38E Waukon	Fair: slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
45B, 45C Maddock	Good	Probable	Improbable: too sandy.	Poor: thin layer.
46 Borup	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
47 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
50 Cashel	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
52 Augsburg	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
56 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
57A, 57B Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
58A, 58B Kittson	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
59 Grimstad	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
60A, 60B2 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
61 Arveson	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, thin layer.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
63: Rockwell	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
64: Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy.
65: Foxhome	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
66: Flaming	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
67A, 67B2: Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
68: Arveson	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
71: Fossum	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
93: Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
127B: Sverdrup	Good	Probable	Improbable: too sandy.	Fair: thin layer.
127C: Sverdrup	Good	Probable	Improbable: too sandy.	Fair: slope, thin layer.
148: Poppleton	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
157A, 157B, 157C: Wahpeton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
180B: Gonvick	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
184B: Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
236: Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
245B: Lohnes	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim.
293B: Swenoda	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
335: Urness	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
343A, 343B2: Wheatville	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
344: Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
402B, 402C-- Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
402D-- Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
402E-- Sioux	Fair: large stones, slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
403-- Viking	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
413-- Osakis	Good	Probable	Probable	Poor: small stones, area reclaim.
425-- Donaldson	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
426-- Foldahl	Fair: wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
429-- Northcote	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
435-- Syrene	Fair: wetness.	Probable	Improbable: too sandy.	Poor: small stones.
494-- Darnen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
506-- Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
508-- Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
509-- Vallers	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
510-- Elmville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
540-- Seelyeville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
543-- Markey	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
544-- Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
545: Rondeau	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
609: Dickey	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
841*: Urban land.				
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
892B*: Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
Sverdrup	Good	Probable	Improbable: too sandy.	Fair: thin layer.
892C*: Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
Sverdrup	Good	Probable	Improbable: too sandy.	Fair: slope, thin layer.
893E*: Lohnes	Fair: slope.	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, slope.
Waukon	Fair: slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
903B*: Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Langhei	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
908*: Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
935*: Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
942C2*:				
Langhei	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
942D2*:				
Langhei	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
966C*:				
Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
966D*:				
Waukon	Fair: slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
967B2*:				
Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Langhei	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
979C2*:				
Langhei	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
979D2*:				
Langhei	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Waukon	Fair: slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
987 Rockwell	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
1001*: Haplaquolls.				

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1001*: Udifluvents.				
1005*. Fluvaquents				
1006*: Fluvaquents.				
Haploborolls.				
1029*. Pits				
1055*: Haplaquolls.				
Histosols.				
1819------------------ Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1854*: Wyndmere, saline-----	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
Wyndmere-------------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
1871------------------ Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
1872------------------ Fargo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
1873------------------ Fargo	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
1874------------------ Lohnes	Good-----------------	Probable-------------	Improbable: too sandy.	Fair: small stones, area reclaim.
1875------------------ Flom	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1876------------------ Divide	Fair: wetness.	Improbable: thin layer.	Improbable: thin layer.	Poor: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
33B: Barnes	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
33B2: Barnes	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
33C2: Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
36: Flom	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
38B: Waukon	Moderate: seepage.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
38B2: Waukon	Moderate: seepage.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
38C: Waukon	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing	Slope.
38C2: Waukon	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
38D: Waukon	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
38D2: Waukon	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
38E: Waukon	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
45B: Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
45C: Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
46: Borup	Severe: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness	Wetness.
47: Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
50: Cashel	Slight	Severe: wetness.	Percs slowly, floods.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
52: Augsburg	Severe: seepage.	Severe: wetness, hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
56: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
57A, 57B: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
58A: Kittson	Moderate: seepage.	Moderate: piping, wetness.	Frost action	Wetness, soil blowing.	Wetness, soil blowing.	Favorable.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
58B Kittson	Moderate: seepage, slope.	Moderate: piping, wetness.	Frost action, slope.	Wetness, slope.	Wetness	Favorable.
59 Grimstad	Severe: seepage.	Severe: piping.	Favorable	Wetness	Erodes easily, wetness, soil blowing.	Erodes easily.
60A Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
60B2 Glyndon	Severe: seepage.	Severe: piping.	Frost action, slope, cutbanks cave.	Wetness, slope.	Wetness	Favorable.
61 Arveson	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
63 Rockwell	Severe: seepage.	Moderate: wetness, piping.	Frost action	Wetness	Wetness	Wetness.
64 Ulen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
65 Foxhome	Severe: seepage.	Severe: piping.	Frost action	Wetness, soil blowing.	Erodes easily, wetness, soil blowing.	Erodes easily.
66 Flaming	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
67A, 67B2 Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
68 Arveson	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
71 Fossum	Severe: seepage.	Severe: seepage, wetness, piping.	Cutbanks cave	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Wetness, droughty.
93 Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
127B Sverdrup	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, droughty.	Too sandy, soil blowing.	Droughty.
127C Sverdrup	Severe: seepage, slope.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
148 Poppleton	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
157A Wahpeton	Moderate: seepage.	Severe: hard to pack.	Deep to water	Slow intake, floods.	Favorable	Favorable.
157B Wahpeton	Moderate: seepage, slope.	Severe: hard to pack.	Deep to water	Slow intake, slope, floods.	Favorable	Favorable.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
157C Wahpeton	Severe: slope.	Severe: hard to pack.	Deep to water	Slow intake, slope, floods.	Slope	Slope.
180B Gonvick	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
184B Hamerly	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
236 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
245B Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
293B Swenoda	Severe: seepage.	Severe: piping.	Favorable	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
335 Urness	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
343A Wheatville	Severe: seepage.	Severe: hard to pack.	Frost action, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.	Percs slowly.
343B2 Wheatville	Severe: seepage.	Severe: hard to pack.	Frost action, percs slowly, slope.	Wetness, percs slowly, slope.	Wetness, percs slowly.	Percs slowly.
344 Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.
402B Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Too sandy	Droughty, rooting depth.
402C, 402D Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
402E Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Large stones, droughty, fast intake.	Slope, large stones, too sandy.	Large stones, slope, droughty.
403 Viking	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
413 Osakis	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
425 Donaldson	Severe: seepage.	Severe: hard to pack.	Percs slowly, frost action.	Wetness, soil blowing, percs slowly.	Wetness, soil blowing, percs slowly.	Percs slowly.
426 Foldahl	Severe: seepage.	Severe: piping.	Frost action	Wetness, droughty, fast intake.	Soil blowing, wetness, erodes easily.	Erodes easily, droughty.
429 Northcote	Slight	Severe: wetness, hard to pack.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
435 Syrene	Severe: seepage.	Severe: seepage, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy.	Wetness, droughty.
494 Darnen	Moderate: seepage.	Severe: piping.	Favorable	Wetness	Erodes easily, wetness.	Erodes easily.
506 Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
508 Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
509 Vallers	Slight	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
510 Elmville	Severe: seepage.	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, soil blowing.	Wetness, soil blowing, percs slowly.	Percs slowly.
540 Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
543 Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
544 Cathro	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing, rooting depth.	Ponding, soil blowing.	Wetness, rooting depth.
545 Rondeau	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing.	Wetness.
609 Dickey	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
841*: Urban land.						
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
892B*: Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Too sandy	Droughty, rooting depth.
Sverdrup	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Too sandy, soil blowing.	Droughty.
892C*: Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
Sverdrup	Severe: seepage, slope.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
893E*:						
Lohnes	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing, slope.	Droughty, slope.
Waukon	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
903B*:						
Barnes	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Langhei	Moderate: slope, seepage.	Moderate: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
908*:						
Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
935*:						
Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
942C2*, 942D2*:						
Langhei	Severe: slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
966C*:						
Waukon	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing	Slope.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
966D*:						
Waukon	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
967B2*:						
Waukon	Moderate: seepage.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
Langhei	Moderate: slope, seepage.	Moderate: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
979C2*, 979D2*:						
Langhei	Severe: slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
979C2*, 979D2*:						
Waukon	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
987 Rockwell	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
1001*:						
Haplaquolls.						
Udifluvents.						
1005*. Fluvaquents						
1006*:						
Fluvaquents.						
Haploborolls.						
1029*. Pits						
1055*:						
Haplaquolls.						
Histosols.						
1819 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
1854*:						
Wyndmere, saline	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave, excess salt.	Wetness, soil blowing, excess salt.	Wetness, too sandy, soil blowing.	Excess salt.
Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
1871 Fargo	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
1872 Fargo	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness	Wetness, percs slowly.
1873 Fargo	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding	Wetness, percs slowly.
1874 Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
1875 Flom	Slight	Severe: ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
1876 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
33B, 33B2, 33C2-- Barnes	0-9	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	9-18	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	18-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
36--------------- Flom	0-14	Clay loam--------	OL, CL-ML, CL	A-4, A-6, A-7	0	95-100	95-100	80-100	60-90	20-50	5-20
	14-23	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-50	10-30
	23-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-98	80-95	60-90	20-50	10-30
38B-------------- Waukon	0-10	Fine sandy loam	SM, SM-SC	A-4	0	95-100	90-98	60-70	35-50	15-25	1-7
	10-34	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	34-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
38B2------------- Waukon	0-10	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0	95-100	90-98	80-95	60-90	20-50	3-30
	10-34	Clay loam, loam	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	34-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
38C-------------- Waukon	0-10	Fine sandy loam	SM, SM-SC	A-4	0	95-100	90-98	60-70	35-50	15-25	1-7
	10-34	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	34-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
38C2------------- Waukon	0-10	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0	95-100	90-98	80-95	60-90	20-50	3-30
	10-34	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	34-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
38D-------------- Waukon	0-10	Fine sandy loam	SM, SM-SC	A-4	0	95-100	90-98	60-70	35-50	15-25	1-7
	10-34	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	34-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
38D2------------- Waukon	0-10	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0	95-100	90-98	80-95	60-90	20-50	3-30
	10-34	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	34-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
38E-------------- Waukon	0-8	Fine sandy loam	SM, SM-SC	A-4	0	95-100	90-98	60-70	35-50	15-25	1-7
	8-28	Clay loam, loam	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	28-60	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
45B, 45C--------- Maddock	0-10	Fine sand--------	SM	A-2	0	100	100	50-80	15-35	---	NP
	10-60	Sand, loamy fine sand, fine sand. sand.	SM, SP-SM	A-2, A-3	0	100	95-100	60-95	5-35	---	NP

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
46---------------- Borup	0-9	Loam--------------	OL, ML	A-4	0	100	100	95-100	70-95	20-34	NP-7
	9-18	Very fine sandy loam, loamy very fine sand, silt loam.	ML	A-4	0	100	100	90-100	60-95	<30	NP-5
	18-60	Loamy very fine sand, very fine sandy loam.	ML	A-4	0	100	100	85-100	50-90	<30	NP-5
47---------------- Colvin	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	11-23	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	23-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
50---------------- Cashel	0-17	Silty clay--------	CH, CL	A-7	0	100	100	95-100	85-100	45-70	20-40
	17-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	85-100	45-70	20-40
52---------------- Augsburg	0-10	Silt loam---------	ML, CL, OL, CL-ML	A-4, A-6	0	100	100	95-100	50-90	15-40	NP-15
	10-18	Loam, very fine sandy loam, silt loam.	ML	A-4	0	100	100	95-100	50-90	20-40	NP-10
	18-31	Loamy very fine sand, very fine sandy loam, loam.	ML	A-4	0	100	100	95-100	50-85	20-40	NP-10
	31-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-90	35-55
56---------------- Fargo	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	9-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	24-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
57A, 57B---------- Fargo	0-12	Silty clay--------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	12-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	24-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
58A--------------- Kittson	0-10	Fine sandy loam	SM, ML, SC, CL	A-4	0	100	95-100	80-90	35-55	15-30	NP-10
	10-17	Loam, fine sandy loam, sandy loam.	CL, SC	A-6	0-5	90-100	65-100	60-90	40-75	20-40	10-20
	17-60	Loam, clay loam	CL	A-6	0-2	95-100	85-98	80-90	50-75	20-40	10-20
58B--------------- Kittson	0-10	Loam--------------	CL, CL-ML	A-6, A-4	0	100	95-100	85-95	50-75	20-40	5-20
	10-17	Loam, fine sandy loam, sandy loam.	CL, SC	A-6	0-5	90-100	65-100	60-90	40-75	20-40	10-20
	17-60	Loam, clay loam	CL	A-6	0-2	95-100	85-98	80-90	50-75	20-40	10-20
59---------------- Grimstad	0-15	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	100	80-100	15-50	15-30	NP-7
	15-38	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	90-100	80-90	5-35	<25	NP-4
	38-60	Sandy loam, fine sandy loam, loam.	SC, CL, SM-SC, CL-ML	A-4, A-6	0-3	95-100	90-100	70-90	40-85	15-40	5-20
60A--------------- Glyndon	0-13	Loam--------------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	13-31	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	31-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
60B2-------------- Glyndon	0-10	Loam-------------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	10-25	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	25-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
61--------------- Arveson	0-14	Clay loam--------	OL, ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
	14-34	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	34-60	Fine sand, loamy sand, sandy loam.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
63--------------- Rockwell	0-9	Clay loam--------	OL, ML	A-4	0	100	95-100	85-95	50-75	20-40	NP-10
	9-18	Fine sandy loam, clay loam, loam.	SM, ML, SM-SC, CL-ML	A-4	0	100	95-100	60-85	35-55	15-25	1-7
	18-28	Fine sand, sand, loamy fine sand.	SM	A-2	0	100	95-100	65-80	20-35	---	NP
	28-60	Silt loam, loam, clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4	0-1	95-100	90-100	70-90	40-85	15-40	5-20
64--------------- Ulen	0-13	Fine sandy loam	SM, SM-SC, SC	A-4	0	100	100	85-95	35-50	15-30	NP-8
	13-19	Sandy loam-------	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	19-60	Fine sand, loamy fine sand.	SM	A-2	0	100	95-100	80-100	15-35	---	NP
65--------------- Foxhome	0-10	Fine sandy loam	SM	A-4	0-2	95-100	90-100	75-90	35-50	<30	NP-5
	10-18	Loamy sand, sandy loam, loam.	SM, SP-SM	A-2, A-4	0-2	95-100	85-100	55-80	10-50	20-30	NP-5
	18-27	Gravelly sand, very gravelly loamy coarse sand, gravelly loamy sand.	SP, SP-SM, GP, GP-GM	A-1	2-5	50-75	40-60	20-50	0-10	---	NP
	27-60	Loam, clay loam, fine sandy loam.	ML, CL, SM, SC	A-4, A-6 A-2	1-5	90-100	85-100	60-90	30-80	20-40	NP-15
66--------------- Flaming	0-13	Fine sand--------	SP-SM	A-3	0	100	100	75-90	5-10	---	NP
	13-60	Fine sand, loamy fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	100	100	75-90	5-30	---	NP
67A, 67B2-------- Bearden	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
	9-24	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	24-60	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
68--------------- Arveson	0-14	Clay loam--------	OL, ML	A-4	0	100	95-100	85-90	50-80	20-40	NP-10
	14-34	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	34-60	Fine sand, loamy sand, sandy loam.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
71--------------- Fossum	0-18	Loamy sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	60-80	10-35	<20	NP-4
	18-60	Sand, fine sand	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP
93--------------- Bearden	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-50	10-25
	12-31	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	31-60	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
127B, 127C------- Sverdrup	0-9	Sandy loam-------	SM	A-4	0	100	95-100	60-70	35-50	---	NP
	9-21	Loam, sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	21-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP
148-------------- Poppleton	0-8	Fine sand--------	SP-SM, SM	A-3, A-2	0	100	100	80-95	5-25	---	NP
	8-60	Fine sand, sand	SM, SP	A-3, A-2	0	100	100	80-95	3-15	---	NP
157A, 157B, 157C- Wahpeton	0-34	Silty clay-------	CH	A-7	0	100	100	95-100	80-95	50-75	25-50
	34-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	80-95	35-75	25-50
180B------------- Gonvick	0-11	Clay loam--------	ML, CL, CL-ML	A-4, A-6	0-3	95-100	90-98	85-95	50-75	20-40	3-20
	11-22	Loam, clay loam, sandy clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6, A-7	0-3	95-100	90-98	70-90	40-70	15-45	5-25
	22-60	Loam, sandy loam, clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6	0-3	95-100	90-98	70-95	35-70	20-40	5-20
184B------------- Hamerly	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	10-24	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
236-------------- Vallers	0-13	Loam-------------	OL, CL, ML	A-6, A-7	0	95-100	95-100	95-100	85-95	30-50	11-20
	13-26	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
245B------------- Lohnes	0-9	Coarse sandy loam	SM, SM-SC	A-2, A-4	0	100	100	60-70	30-40	<20	NP-5
	9-60	Coarse sand, gravelly loamy coarse sand, gravelly coarse sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
293B------------- Swenoda	0-13	Sandy loam-------	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	13-32	Fine sandy loam, sandy loam, loamy sand.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-85	30-55	20-30	NP-10
	32-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	75-100	50-95	25-45	5-20
335-------------- Urness	0-60	Mucky silt loam	OL	A-8, A-4, A-6, A-7	0	100	100	90-100	70-95	20-50	3-20
343A------------- Wheatville	0-9	Silt loam--------	OL, ML, CL, CL-ML	A-4	0	100	100	90-100	50-95	15-35	NP-10
	9-23	Very fine sandy loam, silt loam, loamy very fine sand.	ML, CL, CL-ML	A-4	0	100	100	85-100	50-95	15-35	NP-10
	23-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	90-100	35-80	15-45
343B2------------ Wheatville	0-15	Loam-------------	OL, ML, CL, CL-ML	A-4	0	100	100	90-100	50-95	15-35	NP-10
	15-23	Very fine sandy loam, silt loam, loamy very fine sand.	ML, CL, CL-ML	A-4	0	100	100	85-100	50-95	15-35	NP-10
	23-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	90-100	35-80	15-45
344-------------- Quam	0-12	Clay loam--------	CL, ML, OL	A-6, A-7	0	100	100	90-100	85-95	35-50	15-25
	12-60	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	60-80	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
402B, 402C-------- Sioux	0-9	Sandy loam-------	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	9-14	Gravelly loam, gravelly sandy loam, gravelly loamy coarse sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	14-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
402D-------------- Sioux	0-7	Loamy coarse sand	SM, GM	A-4, A-2	0-5	60-90	50-80	45-70	25-50	20-35	NP-7
	7-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
402E-------------- Sioux	0-3	Bouldery loamy coarse sand.	SM, SW-SM	A-1	20-75	75-100	70-90	25-45	10-25	<25	NP-5
	3-15	Very stony sandy loam, gravelly loamy sand, extremely stony sandy loam.	SM, SM-SC	A-4, A-2, A-1	15-50	60-90	70-85	45-70	15-40	20-30	NP-7
	15-60	Gravelly coarse sand, gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0-15	25-75	10-60	5-35	0-25	<25	NP-5
403--------------- Viking	0-12	Sandy clay loam	CL	A-6	0-5	90-97	90-97	85-95	50-90	20-40	10-20
	12-21	Clay, clay loam, silty clay.	CH, CL	A-7	0-5	90-97	90-97	90-95	80-95	40-85	20-50
	21-60	Clay-------------	CH	A-7	0-5	90-97	90-97	90-95	80-95	60-85	30-50
413--------------- Osakis	0-8	Loam-------------	ML	A-4	0	95-100	90-100	80-95	50-75	20-35	2-10
	8-17	Loam, sandy loam	SM, ML	A-4	0	95-100	85-100	55-90	36-70	15-35	1-10
	17-60	Coarse sand, gravelly coarse sand, gravelly loamy sand.	SP, SM	A-1, A-2	0	30-95	20-85	10-50	0-10	<20	NP
425--------------- Donaldson	0-9	Fine sandy loam	SM, ML	A-4	0	100	100	95-100	35-60	<35	1-5
	9-26	Loamy very fine sand, fine sandy loam, loam.	SM, ML	A-4	0	100	100	95-100	35-60	<35	1-10
	26-32	Loamy very fine sand, very fine sandy loam, very fine sand.	SM	A-4, A-2	0	100	100	95-100	20-50	<30	NP-5
	32-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	95-100	90-100	85-100	60-80	30-50
426--------------- Foldahl	0-11	Loamy fine sand	SM, SP-SM	A-2	0	100	95-100	70-85	12-35	---	NP
	11-29	Fine sand, loamy fine sand, sand.	SP-SM, SM	A-2, A-3	0-3	95-100	90-100	70-85	5-35	---	NP
	29-60	Loam, clay loam, sandy loam.	CL-ML, CL, SM-SC, SC	A-4, A-6	1-5	95-100	70-95	70-90	40-85	15-40	5-20
429--------------- Northcote	0-18	Clay-------------	CH	A-7	0	100	100	95-100	95-100	65-80	35-45
	18-35	Clay-------------	CH	A-7	0	100	100	95-100	90-100	65-85	30-50
	35-60	Clay-------------	CH	A-7	0	100	100	95-100	90-100	65-85	40-60
435--------------- Syrene	0-9	Sandy clay loam	SM, SC, ML, CL	A-4	0-3	95-100	85-100	55-70	35-60	15-30	1-10
	9-17	Loam, sandy loam, sandy clay loam.	SM, ML	A-4	0-3	95-100	85-100	55-75	35-65	20-40	1-10
	17-60	Stratified loamy fine sand to gravelly coarse sand.	SP-SM, SP	A-3, A-1, A-2	2-5	75-95	55-85	30-60	0-10	---	NP

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
494-------------- Darnen	0-25	Loam-------------	OL, ML	A-4	0	100	100	85-100	60-90	20-35	2-10
	25-48	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-90	20-45	5-25
	48-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0	90-100	90-100	80-95	60-85	20-45	5-25
506-------------- Overly	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-45	10-25
	10-19	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-95	25-50	5-30
	19-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-95	25-50	5-30
508-------------- Wyndmere	0-10	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	10-29	Sandy loam, fine sandy loam, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	29-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
509-------------- Vallers	0-13	Loam-------------	OL, CL, ML	A-6, A-7	3-20	95-100	95-100	95-100	85-95	30-50	11-20
	13-26	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
510-------------- Elmville	0-14	Fine sandy loam, very fine sandy loam.	ML, SM	A-4	0	100	100	60-90	35-55	15-30	NP-8
	14-30	Very fine sandy loam, fine sandy loam, loamy fine sand.	SM, ML	A-4, A-2	0	100	100	60-85	20-55	15-30	NP-5
	30-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	95-100	35-65	15-40
540-------------- Seelyeville	0-60	Sapric material	Pt	A-8	0	---	---	---	---	---	---
543-------------- Markey	0-28	Sapric material	Pt	A-8	---	---	---	---	---	---	---
	28-60	Sand, loamy sand	SP, SM, SP-SM	A-2, A-3	0	100	90-100	60-75	0-20	---	NP
544-------------- Cathro	0-21	Sapric material	Pt	A-8	0	---	---	---	---	---	---
	21-60	Loam, silty clay loam, clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	60-100	50-90	20-40	5-25
545-------------- Rondeau	0-50	Muck-------------	Pt	A-8	0	---	---	---	---	---	NP
	50-60	Coprogenous earth	OH	A-8, A-4, A-7, A-6	0	100	100	90-100	70-95	20-50	NP-20
609-------------- Dickey	0-10	Loamy fine sand	SM	A-2-4	0	100	100	50-75	15-30	---	NP
	10-26	Loamy fine sand, loamy sand, fine sand.	SM	A-2-4	0	100	100	50-80	15-35	---	NP
	26-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	24-40	4-20
841*: Urban land.											
Fargo-----------	0-12	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	12-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	24-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
892B*:											
Sioux-----------	0-10	Sandy loam-------	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	10-26	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	26-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
Sverdrup--------	0-10	Sandy loam-------	SM	A-4	0	100	95-100	60-70	35-50	---	NP
	10-15	Loam, sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	15-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP
892C*:											
Sioux-----------	0-8	Sandy loam-------	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	8-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
Sverdrup--------	0-10	Sandy loam-------	SM	A-4	0	100	95-100	60-70	35-50	---	NP
	10-15	Loam, sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	15-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP
893E*:											
Lohnes----------	0-10	Coarse sandy loam	SM, SM-SC	A-2, A-4	0	100	100	60-70	30-40	<20	NP-5
	10-60	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
Waukon----------	0-5	Sandy loam-------	SM, SM-SC	A-4	0	95-100	90-98	60-70	35-50	15-25	1-7
	5-13	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	13-60	Sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
903B*:											
Barnes----------	0-9	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	9-15	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	15-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
Langhei---------	0-7	Loam-------------	CL-ML, CL	A-4, A-6	0	95-100	90-100	75-90	55-80	20-40	5-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	75-90	60-80	20-40	5-25
908*:											
Bearden---------	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-50	10-25
	12-31	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	31-60	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
Fargo-----------	0-12	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	12-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	24-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
935*:											
Hegne	0-9	Silty clay	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
	9-34	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	34-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
Fargo	0-12	Silty clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	12-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
942C2*, 942D2*:											
Langhei	0-8	Loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	75-90	55-80	20-40	5-20
	8-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	75-90	60-80	20-40	5-25
Barnes	0-8	Loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	8-14	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	14-60	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
966C*, 966D*:											
Waukon	0-10	Sandy loam	SM, SM-SC	A-4	0	95-100	90-98	60-70	35-50	15-25	1-7
	10-20	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	20-60	Sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
Sioux	0-8	Sandy loam	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	8-11	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	11-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
967B2*:											
Waukon	0-10	Loam	OL, ML, CL, CL-ML	A-6, A-7, A-4	0	95-100	90-98	80-95	60-90	20-50	3-30
	10-24	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	24-60	Sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
Langhei	0-7	Loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	75-90	55-80	20-40	5-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	75-90	60-80	20-40	5-25
979C2*, 979D2*:											
Langhei	0-7	Loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	75-90	55-80	20-40	5-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	75-90	60-80	20-40	5-25
Waukon	0-8	Loam	OL, ML, CL, CL-ML	A-6, A-7, A-4	0	95-100	90-98	80-95	60-90	20-50	3-30
	8-24	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	24-60	Sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
987 Rockwell	0-9	Clay loam	OL, ML	A-4	0	100	95-100	85-95	50-75	20-40	NP-10
	9-18	Fine sandy loam, sandy loam, loam.	SM, ML, SM-SC, CL-ML	A-4	0	100	95-100	60-85	35-55	15-25	1-7
	18-28	Fine sand, sand, loamy fine sand.	SM	A-2	0	100	95-100	65-80	20-35	---	NP
	28-60	Silt loam, loam, clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4	0-1	95-100	90-100	70-90	40-85	15-40	5-20
1001*:											
Haplaquolls.											
Udifluvents.											
1005*. Fluvaquents											

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1006*:											
Fluvaquents.											
Haploborolls.											
1029*.											
Pits											
1055*:											
Haplaquolls.											
Histosols.											
1819------------- Glyndon	0-29	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-45	10-25
	29-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
1854*: Wyndmere, saline	0-10	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	10-29	Sandy loam, fine sandy loam, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	29-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
Wyndmere--------	0-7	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	7-26	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	26-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
1871------------- Fargo	0-12	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	12-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	24-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
1872------------- Fargo	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	8-28	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	28-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	36-60	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	90-100	80-100	25-50	10-25
1873------------- Fargo	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	10-24	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	24-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	36-60	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	90-100	80-100	25-50	10-25
1874------------- Lohnes	0-14	Sandy loam-------	SM, SM-SC	A-2, A-4	0	100	100	60-70	30-40	<20	NP-5
	14-60	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
1875------------- Flom	0-14	Clay loam--------	OL, CL-ML, CL	A-4, A-6, A-7	0	95-100	95-100	80-100	60-90	20-50	5-20
	14-23	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-50	10-30
	23-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-98	80-95	60-90	20-50	10-30
1876------------- Divide	0-13	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	13-21	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	95-100	85-95	55-80	25-40	5-20
	21-44	Stratified sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
	44-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	25-40	5-20

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
33B, 33B2, 33C2-- Barnes	0-9	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.1-7.8	<2	Low--------	0.28	5	6	2-5
	9-18	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low--------	0.28			
	18-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			
36--------------- Flom	0-14	22-35	1.30-1.45	0.2-2.0	0.18-0.24	6.1-7.8	<2	Moderate	0.28	5	6	5-8
	14-23	24-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-8.4	<2	Moderate	0.28			
	23-60	24-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.28			
38B-------------- Waukon	0-10	4-16	1.30-1.45	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.24	5	3	2-5
	10-34	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	34-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
38B2------------- Waukon	0-10	12-30	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	<2	Moderate	0.24	5	6	3-6
	10-34	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	34-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
38C-------------- Waukon	0-10	4-16	1.30-1.45	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.24	5	3	2-5
	10-34	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	34-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
38C2------------- Waukon	0-10	12-30	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	<2	Moderate	0.24	5	6	3-6
	10-34	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	34-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
38D-------------- Waukon	0-10	4-16	1.30-1.45	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.24	5	3	2-5
	10-34	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	34-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
38D2------------- Waukon	0-10	12-30	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	<2	Moderate	0.24	5	6	3-6
	10-34	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	34-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
38E-------------- Waukon	0-8	4-16	1.30-1.45	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.24	5	3	2-5
	8-28	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	28-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
45B, 45C--------- Maddock	0-10	5-10	1.35-1.45	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2	1-3
	10-60	3-8	1.35-1.45	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17			
46--------------- Borup	0-9	15-27	1.20-1.40	2.0-6.0	0.20-0.23	7.4-8.4	<4	Low--------	0.28	5	4L	4-8
	9-18	10-18	1.30-1.50	2.0-6.0	0.17-0.20	7.4-8.4	<4	Low--------	0.28			
	18-60	5-18	1.35-1.65	2.0-20	0.15-0.19	7.9-8.4	2-8	Low--------	0.28			
47--------------- Colvin	0-11	27-34	1.20-1.50	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L	4-7
	11-23	18-34	1.20-1.50	0.2-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32			
	23-60	18-34	1.30-1.50	0.2-2.0	0.15-0.20	7.4-9.0	<2	Moderate	0.32			
50--------------- Cashel	0-17	40-60	1.20-1.40	0.06-0.6	0.15-0.18	7.4-8.4	<2	High-------	0.32	5	4	4-8
	17-60	35-60	1.30-1.70	0.06-0.6	0.13-0.17	7.4-8.4	<2	High-------	0.32			
52--------------- Augsburg	0-10	10-27	1.20-1.40	0.6-6.0	0.20-0.23	7.4-8.4	<2	Low--------	0.28	5	4L	4-6
	10-18	5-18	1.30-1.50	2.0-6.0	0.20-0.23	7.9-8.4	<2	Low--------	0.28			
	18-31	5-18	1.40-1.60	2.0-6.0	0.17-0.22	7.9-8.4	2-4	Low--------	0.28			
	31-60	35-85	1.10-1.40	<0.2	0.10-0.14	7.4-8.4	<2	High-------	0.28			
56--------------- Fargo	0-9	27-39	1.10-1.30	0.06-0.2	0.18-0.23	6.6-7.8	<2	High-------	0.32	5	7	4-10
	9-24	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
57A, 57B--------- Fargo	0-12	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4	4-10
	12-24	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
58A-------------- Kittson	0-10	5-20	1.35-1.50	2.0-6.0	0.15-0.18	6.6-7.8	<2	Low--------	0.24	5	3	4-6
	10-17	18-30	1.35-1.55	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.32			
	17-60	18-30	1.40-1.65	0.2-2.0	0.15-0.18	7.4-8.4	<2	Moderate	0.32			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
58B----------------	0-10	10-27	1.30-1.45	0.6-2.0	0.20-0.22	6.6-7.8	<2	Low--------	0.24	5	5	4-6
Kittson	10-17	18-30	1.35-1.55	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.32			
	17-60	18-30	1.40-1.65	0.2-2.0	0.15-0.18	7.4-8.4	<2	Moderate	0.32			
59-----------------	0-15	10-18	1.30-1.45	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low--------	0.20	5	3	2-4
Grimstad	15-23	2-15	1.45-1.60	6.0-20	0.08-0.14	7.4-9.0	<2	Low--------	0.20			
	23-60	10-30	1.50-1.65	0.6-2.0	0.11-0.19	7.4-9.0	<2	Low--------	0.37			
60A----------------	0-13	15-27	1.20-1.40	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	4	4L	3-7
Glyndon	13-31	10-18	1.30-1.50	2.0-6.0	0.17-0.20	7.9-9.0	<4	Low--------	0.28			
	31-60	5-18	1.35-1.65	2.0-20	0.15-0.19	7.9-8.4	<4	Low--------	0.28			
60B2---------------	0-10	15-27	1.20-1.40	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	4	4L	3-7
Glyndon	10-25	10-18	1.30-1.50	2.0-6.0	0.17-0.20	7.9-9.0	<4	Low--------	0.28			
	25-60	5-18	1.35-1.65	2.0-20	0.15-0.19	7.9-8.4	<4	Low--------	0.28			
61-----------------	0-14	20-35	1.20-1.35	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	4	4L	5-8
Arveson	14-34	10-27	1.40-1.55	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.24			
	34-60	5-20	1.50-1.65	2.0-20	0.05-0.15	7.4-8.4	<2	Low--------	0.17			
63-----------------	0-9	20-30	1.20-1.45	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.24	5	4L	4-8
Rockwell	9-18	5-30	1.35-1.50	2.0-6.0	0.15-0.17	7.9-8.4	<2	Low--------	0.24			
	18-28	3-10	1.40-1.60	6.0-20	0.05-0.07	7.4-7.8	<2	Low--------	0.24			
	28-60	15-30	1.40-1.60	0.2-2.0	0.18-0.22	7.4-7.8	<2	Low--------	0.24			
64-----------------	0-13	8-20	1.30-1.50	2.0-20	0.20-0.22	7.9-8.4	<4	Low--------	0.17	4	3	2-5
Ulen	13-19	5-12	1.45-1.65	6.0-20	0.10-0.12	7.9-8.4	<4	Low--------	0.17			
	19-60	1-7	1.50-1.70	6.0-20	0.06-0.08	7.9-8.4	<4	Low--------	0.17			
65-----------------	0-10	10-20	1.35-1.50	2.0-6.0	0.14-0.18	6.6-7.3	<2	Low--------	0.20	3	3	3-7
Foxhome	10-18	10-25	1.35-1.50	2.0-20	0.10-0.15	6.6-7.3	<2	Low--------	0.20			
	18-27	5-15	1.50-1.70	6.0-20	0.03-0.05	7.4-7.8	<2	Low--------	0.10			
	27-60	12-35	1.40-1.70	0.6-2.0	0.15-0.21	7.4-8.4	<2	Low--------	0.37			
66-----------------	0-13	2-8	1.45-1.60	6.0-20	0.07-0.09	5.6-7.3	<2	Low--------	0.17	5	1	1-4
Flaming	13-60	2-10	1.50-1.70	6.0-20	0.06-0.10	5.6-8.4	<2	Low--------	0.17			
67A, 67B2----------	0-9	10-26	1.20-1.40	0.6-2.0	0.20-0.24	7.4-8.4	<4	Moderate	0.28	5	4L	3-7
Bearden	9-24	18-34	1.30-1.50	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28			
	24-60	18-34	1.30-1.80	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43			
68-----------------	0-14	20-35	1.20-1.35	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	4	4L	6-10
Arveson	14-34	10-27	1.40-1.55	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.24			
	34-60	5-20	1.50-1.65	2.0-20	0.05-0.15	7.4-8.4	<2	Low--------	0.17			
71-----------------	0-18	4-12	1.35-1.60	6.0-20	0.10-0.12	7.4-8.4	<2	Low--------	0.15	5	2	2-5
Fossum	18-60	1-5	1.50-1.70	6.0-20	0.05-0.09	7.4-8.4	<2	Low--------	0.15			
93-----------------	0-12	27-39	1.20-1.40	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L	3-7
Bearden	12-31	18-34	1.30-1.50	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28			
	31-60	18-34	1.30-1.80	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43			
127B, 127C---------	0-9	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.20	3	3	2-4
Sverdrup	9-21	6-18	1.40-1.55	2.0-6.0	0.10-0.18	6.1-7.8	<2	Low--------	0.20			
	21-60	0-10	1.50-1.65	6.0-20	0.02-0.12	7.4-8.4	<2	Low--------	0.15			
148----------------	0-8	2-10	1.45-1.65	6.0-20	0.08-0.10	5.6-7.3	<2	Low--------	0.15	5	1	1-3
Poppleton	8-60	1-10	1.45-1.65	6.0-20	0.07-0.09	5.6-7.8	<2	Low--------	0.15			
157A, 157B, 157C---	0-34	40-59	1.10-1.30	0.2-2.0	0.14-0.18	6.1-7.8	<2	High-------	0.28	5	4	4-8
Wahpeton	34-60	35-59	1.10-1.40	0.2-2.0	0.13-0.17	7.4-7.8	<2	High-------	0.28			
180B---------------	0-11	10-32	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.24	5	6	2-5
Gonvick	11-22	22-35	1.35-1.50	0.6-2.0	0.15-0.19	6.6-7.3	<2	Moderate	0.32			
	22-60	12-35	1.40-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.32			
184B---------------	0-10	18-35	1.20-1.60	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	4-7
Hamerly	10-24	18-35	1.20-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	24-60	18-35	1.30-1.60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
236-------------- Vallers	0-13	20-27	1.20-1.35	0.2-0.6	0.18-0.22	7.4-8.4	<4	Moderate	0.28	5	4L	5-8
	13-26	18-35	1.40-1.55	0.2-0.6	0.15-0.19	7.9-8.4	<4	Moderate	0.28			
	26-60	18-35	1.50-1.70	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28			
245B------------- Lohnes	0-9	5-15	1.50-1.70	2.0-20	0.10-0.13	6.6-7.3	<2	Low--------	0.24	5	3	1-3
	9-60	0-10	1.50-1.70	6.0-20	0.03-0.07	6.6-8.4	<2	Low--------	0.15			
293B------------- Swenoda	0-13	10-20	1.25-1.35	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low--------	0.20	5	3	2-4
	13-32	10-18	1.30-1.45	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low--------	0.20			
	32-60	20-35	1.35-1.65	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.37			
335-------------- Urness	0-60	18-35	0.25-0.50	0.2-2.0	0.18-0.24	7.4-8.4	<2	Moderate	----	---	4L	>25
343A------------- Wheatville	0-9	15-27	1.25-1.40	2.0-6.0	0.18-0.22	7.4-8.4	<4	Low--------	0.28	4	4L	3-7
	9-23	5-18	1.35-1.55	2.0-6.0	0.15-0.21	7.4-8.4	<4	Low--------	0.28			
	23-60	35-80	1.15-1.50	0.06-0.2	0.10-0.14	7.4-7.8	<4	High-------	0.28			
343B2------------ Wheatville	0-15	15-27	1.25-1.40	2.0-6.0	0.18-0.22	7.4-8.4	<4	Low--------	0.28	4	4L	3-7
	15-23	5-18	1.35-1.55	2.0-6.0	0.15-0.21	7.4-8.4	<4	Low--------	0.28			
	23-60	35-80	1.15-1.50	0.06-0.2	0.10-0.14	7.4-7.8	<4	High-------	0.28			
344-------------- Quam	0-12	28-35	1.00-1.35	0.2-0.6	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	7	6-15
	12-60	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	<2	Moderate	0.28			
	60-80	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
402B, 402C------- Sioux	0-9	10-18	1.25-1.40	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
	9-14	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	14-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
402D------------- Sioux	0-7	10-20	1.30-1.50	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
	7-12	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	12-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
402E------------- Sioux	0-3	2-5	1.45-1.60	6.0-20	0.07-0.09	6.6-8.4	<2	Low--------	0.24	2	8	1-3
	3-15	10-18	1.35-1.45	2.0-6.0	0.08-0.12	6.6-8.4	<2	Low--------	0.24			
	15-60	0-10	1.50-1.70	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
403-------------- Viking	0-12	20-40	1.25-1.45	0.6-2.0	0.18-0.20	6.6-7.8	<2	Moderate	0.32	5	6	3-7
	12-21	35-80	1.30-1.40	<0.06	0.10-0.14	7.4-8.4	<2	High-------	0.32			
	21-60	60-80	1.30-1.45	<0.06	0.09-0.13	7.4-8.4	<2	High-------	0.32			
413-------------- Osakis	0-8	10-22	1.20-1.40	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low--------	0.28	3	5	2-4
	8-17	8-18	1.30-1.50	0.6-6.0	0.14-0.19	6.1-7.3	<2	Low--------	0.28			
	17-60	0-5	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	<2	Low--------	0.10			
425-------------- Donaldson	0-9	5-18	1.30-1.50	2.0-6.0	0.18-0.23	6.6-7.3	<4	Low--------	0.28	5	3	3-6
	9-26	5-20	1.30-1.55	2.0-6.0	0.17-0.21	6.6-7.8	<4	Low--------	0.28			
	26-32	5-18	1.45-1.60	2.0-6.0	0.16-0.19	7.4-8.4	<4	Low--------	0.28			
	32-60	35-70	1.15-1.50	0.06-0.2	0.09-0.13	7.4-8.4	<4	High-------	0.28			
426-------------- Foldahl	0-11	4-9	1.40-1.55	6.0-20	0.10-0.14	6.1-7.8	<2	Low--------	0.20	5	2	1-4
	11-29	4-15	1.45-1.60	6.0-20	0.07-0.12	6.6-7.8	<2	Low--------	0.20			
	29-60	12-35	1.50-1.65	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
429-------------- Northcote	0-18	55-75	1.00-1.20	0.06-0.2	0.13-0.16	6.6-7.3	0-4	High-------	0.28	5	4	3-6
	18-35	60-85	1.15-1.50	0.06-0.2	0.10-0.14	6.6-7.8	0-4	High-------	0.28			
	35-60	60-85	1.15-1.50	0.06-0.2	0.10-0.14	7.4-8.4	0-4	High-------	0.28			
435-------------- Syrene	0-9	20-32	1.20-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low--------	0.28	2	6	3-8
	9-17	10-30	1.30-1.50	2.0-6.0	0.15-0.19	7.9-8.4	<2	Low--------	0.28			
	17-60	2-10	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	<2	Low--------	0.10			
494-------------- Darnen	0-25	18-27	1.25-1.40	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6	4-9
	25-48	18-30	1.40-1.60	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28			
	48-60	18-30	1.55-1.65	0.6-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
506-------------- Overly	0-10	27-39	1.20-1.40	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7	4-8
	10-19	18-34	1.20-1.50	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32			
	19-60	18-59	1.20-1.60	0.2-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32			
508-------------- Wyndmere	0-10	5-15	1.30-1.60	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low--------	0.20	5	3	5-13
	10-29	0-10	1.30-1.70	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20			
	29-60	0-10	1.30-1.70	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20			
509-------------- Vallers	0-13	20-27	1.20-1.35	0.2-0.6	0.18-0.22	7.4-8.4	<4	Moderate	0.28	5	4L	5-8
	13-26	18-35	1.40-1.55	0.2-0.6	0.15-0.19	7.9-8.4	<4	Moderate	0.28			
	26-60	18-35	1.50-1.70	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28			
510-------------- Elmville	0-14	5-18	1.30-1.50	2.0-6.0	0.16-0.22	7.4-8.4	<2	Low--------	0.20	5	3	4-8
	14-30	5-18	1.30-1.55	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20			
	30-60	35-70	1.15-1.45	0.06-0.2	0.10-0.14	7.4-7.8	<2	Moderate	0.28			
540-------------- Seelyeville	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	5.6-7.3	<2	-----------	----	---	3	>25
543-------------- Markey	0-28	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8	<2	-----------	----	---	3	55-85
	28-60	0-10	1.40-1.65	6.0-20	0.03-0.08	6.1-8.4	<2	Low--------	----			
544-------------- Cathro	0-21	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8	<2	-----------	----	---	3	60-85
	21-60	20-35	1.50-2.00	0.2-2.0	0.11-0.22	6.6-8.4	<2	Low--------	----			
545-------------- Rondeau	0-50	0-10	0.10-0.25	0.2-0.6	0.35-0.48	5.1-7.8	<2	-----------	----	---	2	>25
	50-60	5-15	0.05-0.20	<0.2	0.20-0.22	7.4-7.8	<2	-----------	----			
609-------------- Dickey	0-10	2-14	1.40-1.60	6.0-20	0.08-0.12	6.1-7.8	<2	Low--------	0.17	5	2	1-3
	10-26	2-14	1.40-1.60	6.0-20	0.06-0.12	6.1-7.8	<2	Low--------	0.17			
	26-60	18-39	1.30-1.80	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
841*: Urban land.												
Fargo-----------	0-12	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4	4-10
	12-24	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
892B*: Sioux-----------	0-10	10-18	1.25-1.40	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
	10-26	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	26-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
Sverdrup---------	0-10	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.20	3	3	2-4
	10-15	6-18	1.40-1.55	2.0-6.0	0.10-0.18	6.1-7.8	<2	Low--------	0.20			
	15-60	0-10	1.50-1.65	6.0-20	0.02-0.12	7.4-8.4	<2	Low--------	0.15			
892C*: Sioux-----------	0-8	10-18	1.25-1.40	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
	8-12	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	12-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
Sverdrup---------	0-10	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.20	3	3	2-4
	10-15	6-18	1.40-1.55	2.0-6.0	0.10-0.18	6.1-7.8	<2	Low--------	0.20			
	15-60	0-10	1.50-1.65	6.0-20	0.02-0.12	7.4-8.4	<2	Low--------	0.15			
893E*: Lohnes----------	0-10	5-15	1.50-1.70	2.0-20	0.10-0.13	6.6-7.3	<2	Low--------	0.24	5	3	1-3
	10-60	0-10	1.50-1.70	6.0-20	0.03-0.07	6.6-8.4	<2	Low--------	0.15			
Waukon----------	0-5	4-16	1.30-1.45	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.24	5	3	2-5
	5-13	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	13-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
903B*: Barnes----------	0-9	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.1-7.8	<2	Low--------	0.28	5	6	2-5
	9-15	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low--------	0.28			
	15-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
903B*:												
Langhei----------	0-7	18-30	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L	.5-3
	7-60	18-30	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low--------	0.37			
908*:												
Bearden----------	0-12	27-39	1.20-1.40	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L	3-7
	12-31	18-34	1.30-1.50	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28			
	31-60	18-34	1.30-1.80	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43			
Fargo------------	0-12	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4	4-10
	12-24	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
935*:												
Hegne------------	0-9	40-60	1.20-1.35	<0.2	0.14-0.17	7.4-8.4	<2	High-------	0.32	5	4	3-7
	9-34	35-60	1.25-1.40	<0.2	0.13-0.16	7.4-8.4	<4	High-------	0.32			
	34-60	35-60	1.25-1.40	<0.06	0.09-0.16	7.4-8.4	<4	High-------	0.32			
Fargo------------	0-12	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4	4-10
	12-24	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
942C2*, 942D2*:												
Langhei----------	0-8	18-30	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L	.5-3
	8-60	18-30	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low--------	0.37			
Barnes-----------	0-8	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.1-7.8	<2	Low--------	0.28	5	6	2-5
	8-14	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low--------	0.28			
	14-60	18-27	1.50-1.60	0,6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			
966C*, 966D*:												
Waukon-----------	0-10	4-16	1.30-1.45	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.24	5	3	2-5
	10-20	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	20-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
Sioux------------	0-8	10-18	1.25-1.40	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
	8-11	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	11-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
967B2*:												
Waukon-----------	0-10	12-30	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	<2	Moderate	0.24	5	6	3-6
	10-24	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	24-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
Langhei----------	0-7	18-30	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L	.5-3
	7-60	18-30	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low--------	0.37			
979C2*, 979D2*:												
Langhei----------	0-7	18-30	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L	.5-3
	7-60	18-30	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low--------	0.37			
Waukon-----------	0-8	12-30	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	<2	Moderate	0.24	5	6	3-6
	8-24	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32			
	24-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	<2	Moderate	0.32			
987--------------- Rockwell	0-9	20-30	1.20-1.45	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.24	5	4L	4-8
	9-18	5-30	1.35-1.50	2.0-6.0	0.15-0.17	7.9-8.4	<2	Low--------	0.24			
	18-28	3-10	1.40-1.60	6.0-20	0.05-0.07	7.4-7.8	<2	Low--------	0.24			
	28-60	15-30	1.40-1.60	0.2-2.0	0.18-0.22	7.4-7.8	<2	Low--------	0.24			
1001*:												
Haplaquolls.												
Udifluvents.												
1005*.												
Fluvaquents												

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
1006*:												
Fluvaquents.												
Haploborolls.												
1029*. Pits												
1055*:												
Haplaquolls.												
Histosols.												
1819------------- Glyndon	0-29	27-35	1.25-1.40	0.6-2.0	0.18-0.22	7.4-9.0	<4	Moderate	0.28	4	4L	4-8
	29-60	5-18	1.35-1.65	2.0-20	0.15-0.19	7.9-8.4	<4	Low--------	0.28			
1854*:												
Wyndmere, saline	0-10	5-15	1.30-1.60	2.0-6.0	0.13-0.18	7.9-8.4	4-16	Low--------	0.20	5	3	4-8
	10-29	0-10	1.30-1.70	2.0-6.0	0.12-0.17	7.9-8.4	4-16	Low--------	0.20			
	29-60	0-10	1.30-1.70	2.0-6.0	0.06-0.16	7.9-8.4	4-8	Low--------	0.20			
Wyndmere---------	0-7	5-15	1.30-1.60	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low--------	0.20	5	3	5-13
	7-26	0-10	1.30-1.70	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20			
	26-60	0-10	1.30-1.70	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20			
1871------------- Fargo	0-12	40-65	1.00-1.20	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4	4-8
	12-24	40-65	1.15-1.50	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-65	1.15-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
1872------------- Fargo	0-8	40-60	1.10-1.30	0.06-.02	0.15-0.18	6.6-7.3	<2	High-------	0.32	5	4	4-10
	8-28	40-60	1.20-1.45	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	28-60	40-60	1.20-1.45	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
	36-60	20-35	1.30-1.50	0.2-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
1873------------- Fargo	0-10	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.3	<2	High-------	0.32	5	4	4-10
	10-24	40-60	1.20-1.45	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32			
	24-60	40-60	1.20-1.45	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32			
	36-60	20-35	1.30-1.50	0.2-2.0	0.15-0.20	7.9-8.4	<2	Moderate	----			
1874------------- Lohnes	0-14	5-15	1.50-1.70	2.0-20	0.10-0.13	6.6-7.3	<2	Low--------	0.24	5	3	1-3
	14-60	0-10	1.50-1.70	6.0-20	0.03-0.07	6.6-8.4	<2	Low--------	0.15			
1875------------- Flom	0-14	22-35	1.30-1.45	0.2-2.0	0.18-0.24	6.1-7.8	<2	Moderate	0.28	5	6	5-8
	14-23	24-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-8.4	<2	Moderate	0.28			
	23-60	24-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.28			
1876------------- Divide	0-13	15-30	1.10-1.40	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L	2-8
	13-21	18-30	1.20-1.50	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low--------	0.28			
	21-44	0-10	1.30-1.70	>6.0	0.03-0.07	7.9-8.4	<2	Low--------	0.10			
	44-60	15-30	1.30-1.60	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low--------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
33B, 33B2, 33C2 Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
36 Flom	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High	High	Low.
38B, 38B2, 38C, 38C2, 38D, 38D2, 38E Waukon	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
45B, 45C Maddock	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
46 Borup	B/D	Rare	---	---	1.0-2.5	Apparent	Apr-Jul	>60	High	High	Low.
47 Colvin	C/D	Rare	---	---	0-1.0	Apparent	Apr-Jul	>60	High	High	Low.
50 Cashel	C	Occasional	Brief	Mar-May	1.0-3.0	Apparent	Apr-Jul	>60	Moderate	High	Low.
52 Augsburg	B/D	Rare	---	---	1.0-3.0	Apparent	Apr-Jul	>60	High	High	Low.
56, 57A, 57B Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	>60	High	High	Low.
58A, 58B Kittson	C	None	---	---	2.5-6.0	Apparent	Nov-Jun	>60	High	High	Low.
59 Grimstad	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	Moderate	Moderate	Low.
60A, 60B2 Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	High	High	Low.
61 Arveson	B/D	Rare	---	---	1.0-2.0	Apparent	Apr-Jul	>60	High	High	Low.
63 Rockwell	B/D	Rare	---	---	1.0-3.0	Apparent	Apr-Jul	>60	High	High	Low.
64 Ulen	B	Rare	---	---	2.5-6.0	Apparent	Apr-Jul	>60	Moderate	Low	Low.
65 Foxhome	B	None	---	---	2.5-6.0	Apparent	Nov-Jun	>60	High	Moderate	Low.
66 Flaming	A	None	---	---	2.5-6.0	Apparent	Nov-Jun	>60	Moderate	Low	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth*	High water table: Kind	High water table: Months	Bedrock: Depth	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In			
67A, 67B2--------- Bearden	C	None---------	---	---	1.5-2.5	Apparent	Sep-Jun	>60	High---------	High------	Low.
68---------------- Arveson	B/D	Rare---------	---	---	+1-1.0	Apparent	Jan-Dec	>60	High---------	High------	Low.
71---------------- Fossum	A/D	Rare---------	---	---	1.0-2.5	Apparent	Nov-Oct	>60	Moderate-----	High------	Low.
93---------------- Bearden	C	None---------	---	---	1.5-2.5	Apparent	Sep-Jun	>60	High---------	High------	Low.
127B, 127C-------- Sverdrup	B	None---------	---	---	>6.0	---	---	>60	Low----------	Low-------	Low.
148--------------- Poppleton	A	None---------	---	---	2.5-5.0	Apparent	Nov-Jun	>60	Moderate-----	Low-------	Low.
157A, 157B, 157C-- Wahpeton	C	Occasional	Brief------	Mar-Jun	>6.0	---	---	>60	High---------	High------	Low.
180B-------------- Gonvick	B	None---------	---	---	2.5-6.0	Apparent	Nov-Jun	>60	High---------	Moderate	Low.
184B-------------- Hamerly	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	High---------	High------	Low.
236--------------- Vallers	C	Rare---------	---	---	1.0-2.5	Apparent	Nov-Jun	>60	High---------	High------	Low.
245B-------------- Lohnes	A	None---------	---	---	>6.0	---	---	>60	Low----------	Moderate	Low.
293B-------------- Swenoda	B	None---------	---	---	2.5-4.0	Perched	Mar-Jun	>60	Moderate-----	High------	Moderate.
335--------------- Urness	B/D	None---------	---	---	+2-1.0	Apparent	Jan-Dec	>60	High---------	High------	Low.
343A, 343B2------- Wheatville	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	>60	High---------	High------	Low.
344--------------- Quam	B/D	None---------	---	---	+2-1.0	Apparent	Jan-Dec	>60	High---------	High------	Low.
402B, 402C, 402D, 402E-------------- Sioux	A	None---------	---	---	>6.0	---	---	>60	Low----------	Low-------	Low.
403--------------- Viking	D	None---------	---	---	1.0-3.0	Apparent	Apr-Jul	>60	Moderate-----	High------	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
413 Osakis	B	None	---	---	4.0-6.0	Apparent	Nov-Jun	>60	Moderate	Low	Low.
425 Donaldson	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	High	High	Low.
426 Foldahl	B	None	---	---	2.5-6.0	Apparent	Nov-Jun	>60	High	Moderate	Low.
429 Northcote	C/D	Rare	---	---	1.0-3.0	Apparent	Apr-Jul	>60	High	High	Low.
435 Syrene	B/D	None	---	---	1.0-3.0	Apparent	Apr-Jul	>60	Moderate	High	Low.
494 Darnen	B	None	---	---	2.5-6.0	Apparent	Nov-Jun	>60	Moderate	High	Low.
506 Overly	C	None	---	---	>6.0	---	---	>60	High	High	Low.
508 Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	>60	High	High	Low.
509 Vallers	C	None	---	---	1.0-2.5	Apparent	Nov-Jun	>60	High	High	Low.
510 Elmville	B	None	---	---	2.5-5.0	Apparent	Apr-Jul	>60	High	High	Low.
540 Seelyeville	A/D	None	---	---	+2-2.0	Apparent	Jan-Dec	>60	High	High	Moderate.
543 Markey	A/D	None	---	---	+1-1.0	Apparent	Nov-Jun	>60	High	High	Low.
544 Cathro	A/D	None	---	---	+1-1.0	Apparent	Nov-Jun	>60	High	High	Low.
545 Rondeau	D	None	---	---	+1-1.0	Apparent	Jan-Dec	>60	High	High	Low.
609 Dickey	B	None	---	---	>6.0	---	---	>60	Low	High	Low.
841**: Urban land.											
Fargo	D	None	---	---	0-3.0	Apparent	Sep-Jun	>60	High	High	Low.
892B**, 892C**: Sioux	A	None	---	---	>6.0	---	---	>60	Low	Low	Low.
Sverdrup	B	None	---	---	>6.0	---	---	>60	Low	Low	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
893E**:											
Lohnes	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
Waukon	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
903B**:											
Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
Langhei	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
908**:											
Bearden	C	None	---	---	1.5-2.5	Apparent	Sep-Jun	>60	High	High	Low.
Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	>60	High	High	Low.
935**:											
Hegne	D	Rare	---	---	1.0-2.5	Apparent	Apr-Jul	>60	Moderate	High	Low.
Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	>60	High	High	Low.
942C2**, 942D2**:											
Langhei	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
966C**, 966D**:											
Waukon	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Sioux	A	None	---	---	>6.0	---	---	>60	Low	Low	Low.
967B2**:											
Waukon	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Langhei	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
979C2**, 979D2**:											
Langhei	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Waukon	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
987 Rockwell	B/D	Rare	---	---	+1-1.0	Apparent	Jan-Dec	>60	High	High	Low.
1001**:											
Haplaquolls.											
Udifluvents.											
1005**. Fluvaquents.											
1006**:											
Fluvaquents.											

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
1006**: Haploborolls.											
1029**. Pits											
1055**: Haplaquolls.											
Histosols.											
1819 Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	High	High	Low.
1854**: Wyndmere, saline	B	None	---	---	2.0-4.0	Apparent	Sep-Jun	>60	High	High	Moderate.
Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	>60	High	High	Low.
1871 Fargo	D	Rare	---	---	+.5-1.0	Apparent	Jan-Dec	>60	High	High	Low.
1872 Fargo	D	Rare	---	---	1.0-3.0	Apparent	Sep-Jun	>60	High	High	Low.
1873 Fargo	D	Rare	---	---	+1-2.0	Apparent	Jan-Dec	>60	High	High	Low.
1874 Lohnes	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
1875 Flom	B/D	Rare	---	---	+1-2.0	Apparent	Jan-Dec	>60	High	High	Low.
1876 Divide	B	None	---	---	2.5-5.0	Apparent	Sep-Jun	>60	Moderate	High	Low.

*A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

**See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Augsburg	Coarse-silty over clayey, frigid Typic Calciaquolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Borup	Coarse-silty, frigid Typic Calciaquolls
Cashel	Fine, montmorillonitic (calcareous), frigid Mollic Udifluvents
Cathro	Loamy, mixed, euic Terric Borosaprists
Colvin	Fine-silty, frigid Typic Calciaquolls
Darnen	Fine-loamy, mixed Pachic Udic Haploborolls
Dickey	Sandy over loamy, mixed Udorthentic Haploborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Donaldson	Coarse-loamy over clayey, mixed Aquic Haploborolls
Elmville	Coarse-loamy over clayey, frigid Aeric Calciaquolls
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Flaming	Sandy, mixed Aquic Haploborolls
Flom	Fine-loamy, mixed, frigid Typic Haplaquolls
Fluvaquents	Fluvaquents
Foldahl	Sandy over loamy, mixed Aquic Haploborolls
Fossum	Sandy, mixed (calcareous), frigid Typic Haplaquolls
Foxhome	Sandy-skeletal over loamy, mixed Aquic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Gonvick	Fine-loamy, mixed Aquic Argiborolls
Grimstad	Sandy over loamy, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Haplaquolls	Mixed, frigid Haplaquolls
Haploborolls	Loamy, mixed, frigid Haploborolls
Hegne	Fine, frigid Typic Calciaquolls
Histosols	Borosaprists
Kittson	Fine-loamy, mixed Aquic Haploborolls
Langhei	Fine-loamy, mixed (calcareous), frigid Typic Udorthents
Lohnes	Sandy, mixed Udorthentic Haploborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
*Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Northcote	Very-fine, montmorillonitic, frigid Vertic Haplaquolls
Osakis	Sandy, mixed Aquic Haploborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Poppleton	Mixed, frigid Aquic Udipsamments
*Quam	Fine-silty, mixed, frigid Cumulic Haplaquolls
Rockwell	Coarse-loamy, frigid Typic Calciaquolls
*Rondeau	Marly, euic Limnic Borosaprists
Seelyeville	Euic Typic Borosaprists
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Sverdrup	Sandy, mixed Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Syrene	Sandy, frigid Typic Calciaquolls
Udifluvents	Mixed, frigid Udifluvents
Ulen	Sandy, frigid Aeric Calciaquolls
Urness	Fine-silty, mixed (calcareous), frigid Mollic Fluvaquents
Vallers	Fine-loamy, frigid Typic Calciaquolls
Viking	Very-fine, montmorillonitic (calcareous), frigid Typic Haplaquolls
Wahpeton	Fine, montmorillonitic Udertic Haploborolls
Waukon	Fine-loamy, mixed Mollic Eutroboralfs
Wheatville	Coarse-silty over clayey, frigid Aeric Calciaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls

*The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

☆U.S. GOVERNMENT PRINTING OFFICE: 1982—376-599/2031

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.